Alaska Outer Continental Shelf

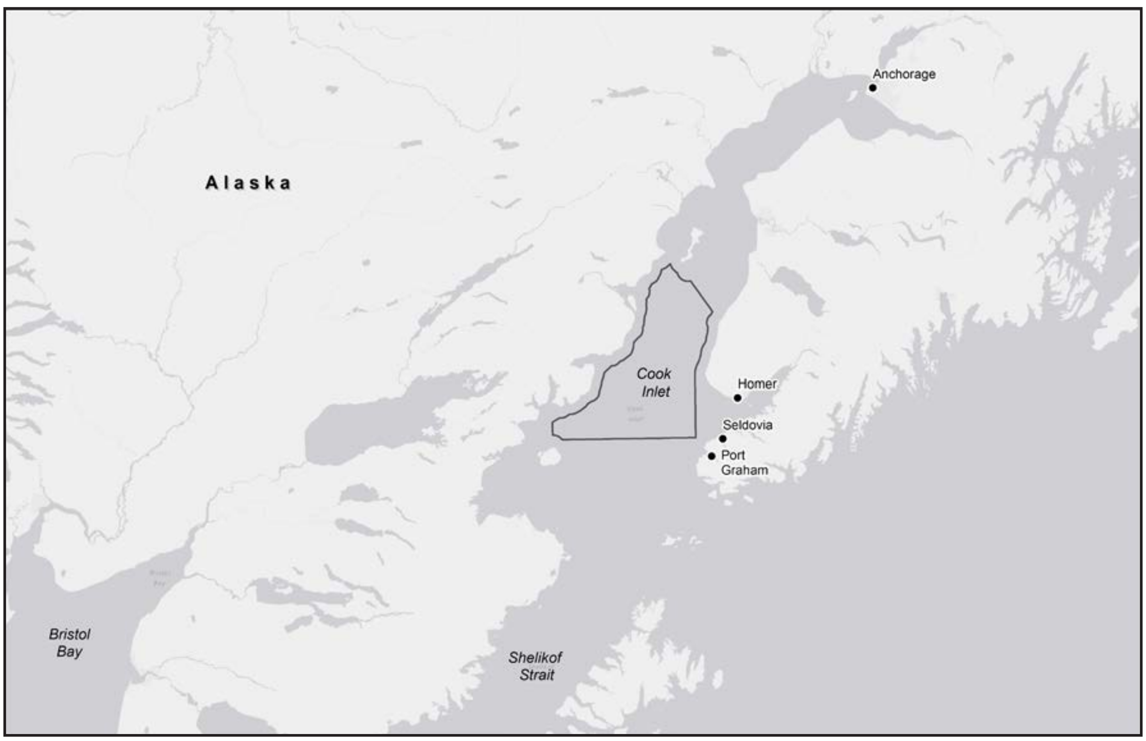
OCS EIS/EA
BOEM 2016-004

Cook Inlet Planning Area

Oil and Gas Lease Sale 244
In the Cook Inlet, Alaska

Draft Environmental Impact Statement

Volume 1. Chapters 1-4



U.S. Department of the Interior
Bureau of Ocean Energy Management
Alaska OCS Region

June 2016

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Prepared by
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June 2016

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COVER SHEET

Cook Inlet
Lease Sale 244
Draft Environmental Impact Statement

	Draft (X)	**Final ( )**
Type of Action:	Administrative (X)	Legislative ( )

Area of Potential Effect: Offshore marine environment, Cook Inlet region, and the Kenai Peninsula Borough of Alaska.

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Abstract:

This environmental impact statement (EIS) assesses a proposed oil and gas lease sale in the Final 2012-2017 Five-Year Oil and Gas Leasing Program for the Cook Inlet Outer Continental Shelf (OCS) Planning Area. The Department has scheduled Lease Sale 244 for 2017. The Proposed Action (to conduct proposed Lease Sale 244) includes consideration of 224 OCS blocks in the northern portion of the Cook Inlet Planning Area, covering about 1.09 million acres (442,875 hectares), representing approximately 20% of the total Cook Inlet Planning Area.

For each alternative, the EIS evaluates the effects to the human, physical, and biological resources from routine activities and from the unlikely chance of a large oil spill. In addition to the Proposed Action, other alternatives include Alternative 2 (No Lease Sale), which means cancellation of the sale; two alternatives (Alternatives 3 and 4), which would exclude blocks overlapping with critical habitat for beluga whales (Alternative 3A) or northern sea otters (Alternative 4A) from leasing, or provide mitigation for critical habitat (Alternatives 3B and 4B) or for beluga whale feeding areas near anadromous streams (3C); Alternative 5, which includes mitigation to reduce interactions with the gillnet fishery; and Alternative 6, which prohibits drilling discharges. A cumulative effects analysis evaluates the environmental effects of the Proposed Action with past, present, and reasonably foreseeable future OCS lease sales, as well as non-OCS activities.

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Acronyms and Abbreviations

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LIST OF ACRONYMS

~ .... about
< .... less than
> .... greater than
± .... plus-minus
≥ .... equal to or greater than
° .... degree(s)
°C .... degrees Celsius
°F .... degrees Fahrenheit
µ .... micron(s)
µg .... microgram(s)
µg/L .... microgram(s) per liter
µg/m^3 .... microgram(s) per cubic meter
2D .... two-dimensional
3D .... three-dimensional
AAC .... Alaska Administrative Code
AAPA .... American Association of Port Authorities
AAQS .... Ambient Air Quality Standards
ABWC .... Alaska Beluga Whale Committee
ac .... acre(s)
ACAIS .... Air Carrier Activity Information System
ACC .... Alaska Coastal Current
ACHP .... Advisory Council on Historic Preservation
ACMP .... Alaska Coastal Management Plan
ADEC .... Alaska Department of Environmental Conservation
ADFG .... Alaska Department of Fish and Game
ADLWD .... Alaska Department of Labor and Workforce Development
ADNR .... Alaska Department of Natural Resources
AEC .... Alaska Earthquake Center
AFB .... Air Force Base
AFSC .... Alaska Fisheries Science Center
AGL .... above ground level (altitude)
AKNHP .... Alaska Natural Heritage Program
AKORN .... Alaska-Oregon Network
AMHS .... Alaska Marine Highway System
AMMC .... Aleut Marine Mammal Commission
AMNWR .... Alaska Maritime National Wildlife Refuge
AMSA .... Area Meriting Special Attention
ANC .... Anchorage International Airport
ANCSA .... Alaska Native Claims Settlement Act
ANHSC .... Alaska Native Harbor Seals Commission
ANILCA .... Alaska National Interest Land Conservation Act
ANMP .... Aniakchak National Monument and Preserve
AOGA .... Alaska O&G Association
APD .... Application for Permit to Drill
APDES .... Alaska Pollutant Discharge Elimination System

API .... American Petroleum Institute
AQCR .... Air Quality Control Regions
ARRC.. Alaska Railroad Corporation
ARSP .... Alaskan Residents Statistics Program
ASGDC .... Alaska State Geo-Spatial Data Clearinghouse
ASTt... Arctic Small Tool tradition
AWOIS .... Automated Wreck and Obstruction Information System
AWQS.. Alaska Water Quality Standards
B.P... Before Present
Ba .... barium
BA .... Biological Assessment
BACT... Best Available Control Technology
Bbbl... billion barrels
BBNC... Bristol Bay Native Corporation
Bcf... Billion cubic feet
BEA .... Bureau of Economic Analysis
BGEPA .... Bald and Golden Eagle Protection Act
BIA.. Small and Resident Biologically Important Area
BLM .... Bureau of Land Management
BlueCrest .... BlueCrest Alaska Operating LLC
BMI .... body mass index
BO .... Biological Opinion
BOD .... biological oxygen demand
BOEM .... Bureau of Ocean Energy Management
BOF .... Board of Fisheries
BOP .... blowout preventer (system)
BRFSS .... Behavioral Risk Factor Surveillance System
BSEE.. Bureau of Safety and Environmental Enforcement
C&T .... customary and traditional
CAA .... Clean Air Act
Cd.. cadmium
CDC .... Center for Disease Control
CDFO... Canadian Department of Fisheries and Oceans
CDP .... Census Designated Place
CEQ .... Council on Environmental Quality
CFR .... Code of Federal Regulations
CH_4 .... methane
CHIRP .... Compressed high-intensity radiated pulse
CIB .... Cook Inlet beluga
CIMMC .... Cook Inlet Marine Mammal Council
CINGSA..................................... Cook Inlet Natural Gas Storage of Alaska
CIRI .... Cook Inlet Region, Inc.
cm.. centimeter(s)
CMA .... Chignik Management Area
CMAN .... Coastal-Marine Automated Network
Co .... cobalt
CO .... carbon monoxide

CO_2 .... carbon dioxide
COSEWIC .... Committee on the Status of Endangered Wildlife in Canada
CPH.. common property harvest
Cr .... chromium
CSEM...................................... controlled source electromagnetic
CSIS .... Community Subsistence Information System
CT .... Chlamydia trachomatis
CTS .... compound threshold shift
Cu... copper
CV .... coefficient of variation
CWA .... Clean Water Act
CZMA .... Coastal Zone Management Act
dB re 1 μPa............................. decibels re 1 microPascal
DCCED .... Department of Commerce, Community, and Economic Development
DDT .... dichloro-diphenyl-trichloroethane
DECC...................................... Department of Energy and Climate Change
DEMs .... Digital Elevation Model(s)
DOT&PF................................. Department of Transportation & Public Facilities
DP .... dynamic positioning
DPP .... Development and Production Plan
DPS .... Discrete Population Segment
DWC .... Division of Wildlife Conservation
E&D .... exploration and development
E.O. .... Executive Order
EA .... Environmental Assessment
EBD .... environmental baseline document
EDPS...................................... eastern DPS
EEZ .... Exclusive Economic Zone
EFH.. Essential Fish Habitat
EIS .... Environmental Impact Statement
EMAP .... Environmental Monitoring and Assessment Program
EO .... Executive Order
EP... Exploration Plan
EPA .... Environmental Protection Agency
EPAct .... Energy Policy Act
ERA .... Environmental Resource Area
ESA .... Endangered Species Act
ESI .... Environmental Sensitivity Index
ESP... Environmental Studies Program
EVOS .... *Exxon Valdez* oil spill
EVOSTC................................. *Exxon Valdez* Oil Spill Trustee Council
FAA .... Federal Aviation Administration
FERC .... Federal Energy Regulatory Commission
FLM .... Federal Land Manager
FMC .... Fishery Management Council
FMP .... Fishery Management Plan
FONSI..................................... Finding of No Significance Impact

FOSC .... Federal On-Scene Coordinator
FR... Federal Register
FSB .... Federal Subsistence Board
ft .... foot/feet
ft^2.. square foot/feet
g .... gravitational acceleration
g C/m^2 .... grams of carbon per square meter
G&G... geological and geophysical
GAP .... Gulf Apex Predator-Prey
GC .... Neisseria gonorrhea
GCI... General Communication Inc.
GESAMP .... Joint Group of Experts on the Scientific Aspects of Marine Protection
GHG .... greenhouse gases
GIS .... Geographic Information System
GIUE .... government-initiated unannounced exercises
GLS .... Grouped Land Segment
GMU .... Game Management Unit
GMWD .... Global Maritime Wrecks Database
GOALS .... Gulf of Alaska Line-Transect Survey
ha.. hectare(s)
HAPC.. Habitat Area of Particular Concern
HCA .... Habitat Conservation Area
HEA .... Homer Electric Association
HFC... hydrofluorocarbon(s)
Hg... mercury
HIV .... human immunodeficiency virus
Hz... hertz
IBA... Important Bird Area
ID .... Identification (Area Identification = Area ID)
IHA .... Incidental Harassment Authorization
IMO... International Maritime Organization
in. .... inch(es)
in^3 .... cubic inch(es)
INC... Incident of Non-Compliance
IOGP .... International Association of Oil & Gas Producers
IPCC.. Intergovernmental Panel on Climate Change
IPF... impact-producing factor(s)
IPHC .... International Pacific Halibut Commission
IR .... infrared
ITL .... Information to Lessees (Clauses)
ITS .... Incidental Take Statement
IUCN/SSG .... World Conservation Union/Species Survival Commission
IWC... International Whaling Commission
JBER .... Joint Base Elmendorf Richardson
KANA .... Kodiak Area Native Association
KBNERR .... Kachemak Bay National Estuarine Research Reserve
Kg... kilogram(s)

kHz..kilohertz(s)
km ....kilometer(s)
kn ....knot(s)
KPB...Kenai Peninsula Borough
LA ....Launch Area
lb ....pound(s)
LNG ....liquefied natural gas
LOA ....Letter of Authorization
LS..Land Segment
LTO...landing takeoff operations
m ....meter(s)
m/s..meters per second
MAPP..Mobilizing for Action through Planning and Partnerships
MARPOL..................................International Convention for the Prevention of Pollution from Ships
MBTA..Migratory Bird Treaty Act
Mcf..thousand cubic feet
MEA..Marine Exchange of Alaska
mg/L..milligram per liter
MHW ....mean high water
MHHW ....mean higher high water
mi ....mile(s)
mL ....milliliter(s)
MLW...mean low water
MLLW ....mean low low water
min ....minute(s)
mm ....millimeter
MMbbl ....millions of barrel(s)
MMC...Marine Mammal Commission
MMPA ....Marine Mammal Protection Act
MMS ....Minerals Management Service
Mo...molybdenum
MODU ....mobile offshore drilling unit
MPA..Marine Protected Area
mph ....miles per hour
MSA..Magnuson-Stevens Act
MSD..marine sanitation device
MTBE ....methyl tertiary butyl ether
Mw..moment magnitude
MW ....megawatt(s)
N_2O ....nitrous oxide
NAAQS......................................National Ambient Air Quality Standards
NavAids ....Aids to Navigation
NAWQUA ....National Water-Quality Assessment
NCDC ....National Climatic Data Center
NEPA ....National Environmental Protection Act
NERR..National Estuarine Research Reserve
NHPA..National Historic Preservation Act

Ni .... nickel
NMFS.. National Marine Fisheries Service
nmi .... nautical mile(s)
NMML .... National Marine Mammal Laboratory
NO_2 .... nitrogen dioxide
NOA.. Notice of Availability
NOAA .... National Oceanographic and Atmospheric Administration
NOI .... Notice of Intent
NOS .... Notice of Sale
NOx... nitrogen oxides
NPDES...................................... National Pollutant Discharge Elimination System
NPFMC..................................... National Pacific Fisheries Management Council
NPP .... National Park and Preserve
NPRW....................................... North Pacific Right Whale
NPS .... National Park Service
NRC .... National Research Council
NRDA .... National Resource Damage Assessment
NRHP.. National Register of Historic Places
NTL... Notice to Lessees and Operators
NWI .... National Wetlands Inventory
NWR .... National Wildlife Refuge
O&G.. oil and gas
O_3 .... ozone
o-p .... zero to peak
OBN .... ocean-bottom node
OCD .... Offshore and Coastal Dispersion
OCS... Outer Continental Shelf
OCSLA .... Outer Continental Shelf Lands Act
ODCE.. Ocean Discharge Criteria Evaluation
OECM .... Offshore Environmental Cost Model
OPD .... Official Protraction Diagram
OSM.. Office of Subsistence Management
OSR... oil spill response
OSRA.. Oil-Spill Risk Analysis
OSRP .... Oil-Spill-Response Plan
OSRV.. oil spill response vessel
OST... oil storage tanker
OSTLF .... Oil Spill Liability Trust Fund
OSV/OSRV............................... offshore supply vessels
P.L... Public Law
p-p .... peak to peak
PAC’s.. polyaromatic compound(s)
PAH .... polycyclic aromatic hydrocarbon(s)
Pb .... lead
PCB... polychlorinated biphenyl(s)
PCE .... primary constituent element(s)
PFC .... perfluorocarbon(s)

PID .... pelvic inflammatory disease
PL .... pipeline segment
PM .... particulate matter
PM_{10} .... particulate matter less than 10 microns in diameter
$PM_{2.5}$ .... particulate matter less than 2.5 microns in diameter
PNA .... Petroleum News Alaska
POD .... Plan of Development
POP .... platform of opportunity
ppb .... parts per billion
ppm .... parts per million
ppt .... parts per thousand
PRC .... PackRim Coal, LP
PSD .... Prevention of Significant Deterioration
PTS .... permanent threshold shift
PU .... personal use
PWS .... Prince William Sound
RD .... Regional Director
REACH .... Racial and Ethnic Approaches to Community Health
RFI .... Request for Interest
RIMS II .... Regional Input-Output Modeling System
R_{ms} .... root mean-squared
ROD .... Record of Decision
ROV .... remotely operated vehicle
RS/FO .... Regional Supervisor/Field Operations
RSLP .... Regional Supervisor, Leasing and Plans
RY09 .... Regulatory year 2009
SAE .... SAExploration, Inc.
Sb .... antimony
SBF .... synthetic-based fluid
Se .... selenium
SEAK .... Southeast Alaska
SEL .... sound exposure level
SEMS .... Safety and Environmental Management System
SF_6 .... sulfur hexafluoride
SHARCs .... Subsistence Halibut Registration Certificates
SHPO .... State Historic Preservation Officer
Sn .... tin
SO_2 .... sulfur dioxide
SO_4 .... sulfate
SOLAS .... International Convention for Safety of Life at Sea
SPCC .... Spill Prevention, Control, and Countermeasure
SPL .... sound pressure level
SSB .... State Seaward Boundary
STIs .... sexually transmitted infection(s)
SUA .... Subsistence use area
sVGP .... small Vessel General Permit
TATEC .... Turnagain Arm Tidal Energy Corporation

TB .... tuberculosis
Tcf .... trillion cubic feet
THPO .... Tribal Historic Preservation Officer(s)
TOC .... total organic carbon(s)
TSS .... total suspended solid(s)
TTS .... temporary threshold shift(s)
U.S. .... United States
U.S.C. .... United States Code
UAF .... University of Alaska, Fairbanks
UCIDA .... United Cook Inlet Drift Association
UERR .... undiscovered economic recoverable resource
UME .... Unusual Mortality Event
UNFCCC .... United Nations Framework Convention on Climate Change
USACE .... U.S. Army Corps of Engineers
USCB .... U.S. Census Bureau
USCG .... U.S. Coast Guard
USDA .... U.S. Department of Agriculture
USDOC .... U.S. Department of Commerce
USDoD .... U.S. Department of Defense
USDOE .... U.S. Department of Energy
USDOI .... U.S. Department of the Interior
USDOT .... U.S. Department of Transportation
USEPA .... U.S. Environmental Protection Agency
USFS .... U.S. Forest Service
USFWS .... U.S. Fish and Wildlife Service
USGS .... U.S. Geological Survey
UV .... ultraviolet
V .... vanadium
VGP .... Vessel General Permit
VLOS .... very large oil spill
VOA .... volatile organic analyte
VOC .... volatile organic compound(s)
WBF .... water-based fluid
WHSRN .... Western Hemisphere Shorebird Reserve Network
yd .... yard(s)
yr .... year
Zn .... zinc

EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

INTRODUCTION AND BACKGROUND

The U.S. Department of the Interior (USDOI), Bureau of Ocean Energy Management (BOEM) is proposing to conduct an oil and gas lease sale in the outer continental shelf (OCS) of the Cook Inlet Planning Area, Alaska. Lease Sale 244 would provide qualified bidders the opportunity to bid on OCS blocks to gain conditional rights to explore, develop, and produce oil and natural gas. The proposed Lease Sale Area consists of 224 OCS blocks in the northern portion of the Cook Inlet Planning Area, encompassing approximately 442,875 hectares (ha) (1.09 million acres (ac)), or about 20% of the planning area. This Draft Environmental Impact Statement (EIS) was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code (U.S.C.) 4321 *et seq.*) and the implementing regulations of the Council on Environmental Quality (CEQ) and the U.S. Department of the Interior (USDOI) to assess the potential impacts of the Proposed Action and its alternatives.

PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the Proposed Action is to offer certain OCS blocks located in Federal waters of Cook Inlet that may contain economically recoverable oil and gas resources. The need for the Proposed Action is to further the orderly development of OCS resources in accordance with the Outer Continental Shelf Lands Act of 1953 (OCSLA) (43 U.S.C. 1331 *et seq.*). Lease Sale 244 may lead to oil and gas development and production in the OCS of Cook Inlet. Oil serves as the feedstock for liquid hydrocarbon products including gasoline, aviation and diesel fuel, and various petrochemicals. Natural gas is used for residential and industrial heating and electric power generation and is an important power source and raw material for domestic industries engaged in the manufacture or formulation of fertilizers, pharmaceuticals, plastics, and packaging. Oil and gas from the Cook Inlet OCS could help meet the Nation’s energy needs and lessen the need for imports.

REGULATORY AND ADMINISTRATIVE FRAMEWORK

The OCSLA established the framework for the Federal OCS oil and gas leasing process. It requires the USDOI to manage the orderly leasing, exploration, development, and production of oil and gas resources on the OCS, while simultaneously ensuring the protection of the human, marine, and coastal environments; and ensuring 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, also must comply with NEPA, which requires the integrated use of natural and social sciences in any Federal agency’s planning and decision making processes. Specifically, NEPA requires Federal agencies to prepare an EIS for major Federal actions significantly affecting the quality of the human environment. Other laws, regulations, and Executive Orders (EOs) also are applicable to OCS activities.

SCOPING

Scoping is the ongoing public process to identify issues, alternatives, and mitigation measures to be considered for in-depth analysis in the EIS. In November 2014, BOEM held public scoping meetings in Anchorage, Homer, Nanwalek, Seldovia, and Soldotna, Alaska. Oral, written, and electronic comments were received from a number of people and groups during a public comment period. Respondents included Federal, state, and local government agencies; tribes; interest groups; industry; businesses; and the public. Comments largely focused on impacts to subsistence, impacts to the region’s fish and wildlife communities and aquatic food chain, impacts to commercial, sport, and subsistence fisheries, benefits of the Proposed Action to local economies, impacts to area resources and communities from an accidental oil spill, and possible contribution of the project to climate change. The information gathered during the scoping process was used to identify key issues for impact analysis, and to develop and refine alternatives and mitigation measures.

Parallel to the NEPA scoping process, BOEM also engaged in Government-to-Government consultations with Alaska Native federally recognized tribes, as well as consultations with Alaska Native Claims Settlement Act (ANCSA) corporations.

PROPOSED ACTION AND ALTERNATIVES

The following alternatives were identified for detailed analysis in the Draft EIS:

- Alternative 1 – The Proposed Action (Lease Sale 244). This alternative would offer for lease 224 OCS blocks in the northern portion of the Federal waters of Cook Inlet.
- Alternative 2 – No Action. Under this alternative, Lease Sale 244 would not occur.
- Alternatives 3A, 3B, and 3C – Beluga Whale Critical Habitat Exclusion (3A), Beluga Whale Critical Habitat Mitigation (3B) and Beluga Whale Nearshore Feeding Areas Mitigation (3C). Alternatives 3A and 3B would apply to the 10 OCS blocks that overlap with critical habitat for the Cook Inlet distinct population segment (DPS) of beluga whale. The blocks either would be excluded from the proposed lease sale (Alternative 3A), or included with additional mitigation measures designed to reduce impacts to beluga whale critical habitat (Alternative 3B). Alternative 3C would apply seasonal mitigations to all 224 OCS blocks between November 1 and April 1, and additional mitigation to the 146 OCS blocks located wholly or partially within 10 miles of major anadromous streams.
- Alternatives 4A and 4B – Northern Sea Otter Critical Habitat Exclusion (4A) or Northern Sea Otter Critical Habitat Mitigation (4B). These alternatives would apply to the seven OCS blocks that overlap with critical habitat for the southwest Alaska DPS of the northern sea otter. The blocks either would be excluded from the proposed lease sale (Alternative 4A), or included with additional mitigation measures designed to reduce impacts to northern sea otter critical habitat (Alternative 4B).
- Alternative 5 – Gillnet Fishery Mitigation. This alternative would apply to 105 OCS blocks north of Anchor Point. The alternative includes mitigation for these blocks designed to reduce the potential for interactions with the drift gillnet fishery.
- Alternative 6 – Prohibition of Drilling Discharges. This alternative would offer the same 224 OCS blocks as Alternative 1 but would prohibit all discharges of drilling fluids and cuttings into Cook Inlet.

AFFECTED ENVIRONMENT

The Affected Environment chapter of the Draft EIS describes the physical environment, biological environment, socioeconomic and sociocultural systems, and oil and gas and related infrastructure of and around Cook Inlet that could be affected by the Proposed Action. The following resources are included:

- Air quality
- Water quality
- Acoustic environment
- Lower trophic level organisms
- Fish and shellfish
- Marine mammals
- Terrestrial mammals
- Marine and coastal birds
- Coastal and estuarine habitats
- Economy and population
- Commercial fishing
- Subsistence-harvest patterns
- Sociocultural systems
- Public and community health
- Recreation and tourism, and visual resources
- Sport fishing
- Archaeological and historic resources
- Areas of special concern
- Oil and gas infrastructure
- Environmental justice

ENVIRONMENTAL CONSEQUENCES

A systematic approach was used to verify that all relevant issues were evaluated in the Draft EIS. Information gathered during the scoping process was used to identify key issues and potentially affected resources. A detailed Exploration and Development (E&D) Scenario was prepared to provide the framework and assumptions for impact analysis. Impact-producing factors (IPFs) were identified based on this scenario and quantified to the extent practicable. Impact analysts applied the E&D Scenario and IPF assumptions to assess potential direct, indirect, and cumulative impacts for each resource category.

The results of the impact analysis for the Proposed Action are summarized in Table ES-1. Impacts on each resource category were rated as negligible, minor, moderate, or major using impact scale definitions based on the context and intensity of impact. Separate ratings were produced for routine activities, small spills (< 1,000 barrel (bbl)), and a large spill (≥1,000 bbl). Impacts of routine activities and small spills ranged from negligible to moderate for all resources.

Over the life of the hypothetical development and production that could follow a lease sale, other effects are possible from unlikely events, such as a large, accidental oil spill or natural gas release. BOEM estimates that the mean number of spills greater than or equal to 1,000 barrels is less than one (0.24 (about a quarter of a spill)). The chance of one or more large spills greater than or equal to 1,000 barrels occurring and entering offshore waters is 22% and the chance of no spills occurring is 78%. For purposes of analysis, BOEM analyzes one large offshore spill of either 5,100 barrels (platform spill) or 1,700 barrels (pipeline spill). The low probability of such an event, combined with the characteristics of the resources inhabiting the area (for example, timing of presence in parts of the proposed Lease Sale Area), make it unlikely that a large oil spill would occur and contact these resources. Impacts of a large spill ranged from minor to major. However, if an unlikely large spill were to occur, the analysis identified potentially major impacts to bird, coastal and estuarine habitats, subsistence harvest patterns, sociocultural systems and areas of special concern resources.

Table ES-1. Summary of Potential Impacts From Alternative 1 (Proposed Action).

Resource	Impacts of Alternative 1 (Proposed Action)	Impact Rating[1]		
		Routine Activities	Small Spills	Large Spill
Air quality	Increased air pollutant concentrations due to emissions from engines and generators on drilling rigs, platforms, vessels, and helicopters. Release of VOCs from oil spills.	Minor	Minor	Minor
Water quality	Turbidity due to seafloor disturbance and drilling discharges; water quality impacts from operational discharges; elevated hydrocarbon concentrations in water and sediments from oil spills	Minor	Minor	Moderate
Acoustic environment	Underwater noise from seismic surveys, drilling and construction activities, and support vessels	Minor	Negligible	Minor
Lower trophic level organisms	Burial of benthic organisms due to seafloor disturbance at drilling rig and platform sites; burial and smothering of benthic organisms near exploration wellsites; plankton entrainment and impingement by cooling water intakes	Minor	Minor	Moderate
Fish and shellfish	Alteration of demersal fish habitat due to seafloor disturbance at rig and platform sites and drilling discharges at exploration wellsites; entrainment and impingement of fish eggs and larvae by water intakes	Minor	Minor	Moderate
Marine mammals	Disturbance by underwater noise from seismic surveys, drilling activities, and vessel and helicopter traffic; risk of vessel strikes; lethal and sublethal effects of spills	Negligible to Minor	Negligible	Negligible to Moderate
Terrestrial mammals	Disturbance by onshore support activities and helicopters; impacts of spills on foraging habitat and prey species	Negligible	Negligible	Minor
Birds	Attraction to OCS structures and lights, including risk of bird strikes; lethal and sublethal effects of spills including contamination of Important Bird Areas and bird habitats	Minor to Moderate	Minor	Moderate to Major

Resource	Impacts of Alternative 1 (Proposed Action)	Impact Rating[1]		
		Routine Activities	Small Spills	Large Spill
Coastal and estuarine habitats	Negligible impact from routine activities due to distance from shore; potential for extensive impacts to intertidal habitats including wetlands from spills; with typically expected mitigation from regulatory agencies onshore pipeline construction impacts of wetlands and Anadromous Fish Stream crossings would be further reduced to negligible impacts	Minor	Minor	Major
Economy and population	Minor impact due to direct and indirect employment, taxes, and royalties; no overall impact of small spills; large spills could cause economic impacts through resource damage and disruption of fishing, marine transportation, and port operations	Minor	Negligible	Minor
Commercial fishing	Exclusion zones around drilling rigs and platforms; potential interactions with drift gillnetting including gear loss or damage; effects of discharges and spills on fishery species; disruption of fishing by spill response and cleanup activities	Minor	Minor	Moderate
Subsistence harvest patterns	Potential interactions with subsistence hunters and fishers; effects of spills on subsistence resources; disruption of harvest by spill response and cleanup activities	Minor	Minor	Major
Sociocultural systems	Short-term and limited impact from routine activities; effects of spills on subsistence resources and cultural sites; possible disruption of harvest by spill response and cleanup activities	Minor	Minor	Major
Public and community health	Short-term and localized impact on public health from air pollutant emissions; spills could expose public to oil and VOCs; influx of spill response workers could increase demands on local health systems	Minor	Minor	Moderate
Recreation, tourism, visual resources	Short-term and localized interactions with marine boating and recreational users; negligible impacts of small spills on recreation and tourism; short-term and localized visual and aesthetic impacts from OCS structures and lights and small spills; long-term contamination and widespread but temporary closures of recreational areas due to large spills	Minor	Negligible to Minor	Moderate
Sport fishing	Exclusion zones around drilling rigs and platforms; effects of discharges and spills on fishery species; disruption of fishing by spill response and cleanup activities	Minor	Minor	Moderate
Archaeological resources	Potential impacts to shipwrecks and submerged archaeological resources avoided by conducting archaeological surveys and assessments; spills could contaminate coastal historic and prehistoric sites	Negligible	Minor	Moderate
Areas of special concern	Short-term and localized impact from routine activities; negligible impacts from small spills; large spills could cause extensive, persistent, and severe contamination of shorelines	Minor	Negligible	Major
Oil and gas and related infrastructure	Possible damage to subsea pipelines and cables avoided by conducting geohazard surveys; onshore infrastructure is adequate to support exploration and development; large spills could temporarily shut down existing operations	Negligible	Negligible	Minor
Environmental justice	No disproportionately high and adverse impacts on environmental justice communities from routine activities and small spills; large spills could have disproportionately high and adverse impacts on environmental justice communities.	N/A[2]	N/A[2]	Disproportionately High and Adverse

Notes: [1] The impacts scale applied in this Draft EIS 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

[2] Analysis of the impacts of the Proposed Action found no high and adverse (i.e., major) impacts for routine activities or small spills for any subsistence resource, subsistence harvest patterns, public and community health, and sociocultural systems. Environmental justice analyses only consider high and adverse (i.e., major) impacts (CEQ, 1997a). Therefore, routine activities and small spills do not apply to environmental justice analysis in this EIS.

VOC = volatile organic compound.

Table ES-2 compares the impacts of Alternatives 2-6 relative to Alternative 1 (Proposed Action). The overall impact ratings did not differ among action alternatives for any resource. However, specific differences in impacts were identified for certain resources as summarized in the table.

Table ES-2. Comparison of Impacts Relative to Alternative 1 (Proposed Action)

Alternative	Impacts Avoided or Reduced	Impacts Added or Increased, or Benefits Reduced
2 – No Action	Avoids all impacts of the Proposed Action	Environmental impacts may occur from the likely substitutes for the lost oil and gas production Economic benefits from the Proposed Action would be delayed or eliminated
3A – Beluga CH Exclusion	Avoids most impacts on beluga whales and their CH in 10 OCS blocks May slightly reduce interactions with drift gillnet fishers at northern edge of proposed Lease Sale Area (exclusion would eliminate 10% of the blocks north of Anchor Point) May slightly reduce risk of impacts to archaeological resources (all of the blocks are identified as sensitive for historic and/or prehistoric resources)	—
3B – Beluga CH Mitigation	Reduces impacts on beluga whales and their CH in 10 OCS blocks	—
3C- Beluga Nearshore Feeding Areas Mitigation	Reduces impacts on beluga whale nearshore feeding areas in 146 OCS blocks located within 10 miles of major anadromous streams Eliminates or reduces impacts of noise ≥160 dB on anadromous fish populations in 146 OCS blocks within 10 miles of major anadromous streams	—
4A – Sea otter CH Exclusion	Avoids most impacts on sea otters and their CH in 7 OCS blocks May slightly reduce risk of impacts to archaeological resources (all of the blocks are identified as sensitive for prehistoric resources)	—
4B – Sea otter CH Mitigation	Reduces impacts on sea otters and their CH in 7 OCS blocks	—
5 – Gillnet Fishery Mitigation	Reduces risk of interactions with drift gillnet fishers by prohibiting on-lease seismic surveys during the drift gillnet season and by notifying and coordinating with gillnet fishers	—
6 – Prohibition of Drilling Discharges	Eliminates all impacts of drilling fluids and cuttings discharges (mainly affecting water quality, lower trophic level organisms, fish and shellfish)	Slightly increases vessel traffic and associated air pollutant emissions due to cuttings transport to shore

Note: CH = critical habitat

VERY LARGE OIL SPILL (VLOS) SCENARIO AND EFFECTS

Although very unlikely and not part of the Proposed Action or any alternatives, the potential effects of a Very Large Oil Spill (VLOS) were also analyzed in this Draft EIS as a low-probability, high-impact event. The scenario examined was a hypothetical release of 120,000 bbl of oil resulting from a loss of well control over 80 days. Should a VLOS occur in the proposed Lease Sale Area, all of the resource categories analyzed in the Draft EIS could be adversely affected, with nearly all of the impact levels ranging from moderate to major.

CUMULATIVE EFFECTS

Cumulative effects were analyzed in the Draft EIS by considering the additive, countervailing, and synergistic effects of the Proposed Action when added to other past, present, and reasonably foreseeable future actions.

The cumulative effects analysis considers impacts of other oil and gas activities, renewable energy projects, mining projects, marine transportation, activities at ports and terminals, the Knik Arm Crossing Project, submarine cable projects, wastewater discharges, persistent contaminants and marine trash and debris, dredging and marine disposal, military activities, fishing activities, and climate change.

The incremental contribution from the Proposed Action to the cumulative effects from other sources would likely be quite small.

A large oil spill could contribute additional cumulative effects. The resources with the greatest potential to experience cumulative effects include marine mammals, birds, coastal and estuarine habitats, commercial fishing, subsistence harvesting patterns, recreation and tourism and visual resources, and areas of special concern.

CONSULTATION AND COORDINATION

BOEM has engaged, or will engage, in a number of consultation and coordination processes with Federal agencies regarding proposed activities under Lease Sale 244. Below is a brief summary of how BOEM has satisfied, or will satisfy, its requirements under various Federal regulatory processes.

- **Executive Order 13175 – Tribal Consultation.** In November 2014, BOEM met with the local tribal governments of Seldovia, Nanwalek, and Port Graham. Government-to-Government consultations were held with the Seldovia Village Tribe and Nanwalek Village Tribe, and by teleconference with the Port Graham Tribal Council. For this Draft EIS, BOEM initiated government-to-government tribal consultations by delivering letters to tribes whose members could be affected by activities related to Lease Sale 244. Pursuant to Secretary of the Interior policy, BOEM also initiated consultation with ANCSA corporations through letters to ANCSA corporations whose members could be affected by activities related to Lease Sale 244.
- **Endangered Species Act (ESA) – Section 7 Consultation.** BOEM has initiated consultation with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) about listed species and critical habitat under each service’s jurisdiction. BOEM is requesting incremental Section 7 consultation for Lease Sale 244. Consultation for the first incremental step will include only 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 would reinitiate consultation for any proposed development and production activities.
- **Magnuson-Stevens Fishery Conservation and Management Act (MSA) – Essential Fish Habitat (EFH) Consultation.** BOEM has prepared an EFH assessment that will be submitted to the NMFS to initiate EFH consultation for species of salmon, groundfishes, forage fishes, and scallops.
- **National Historic Preservation Act (NHPA) – Section 106 Consultation.** BOEM will use the NEPA process to satisfy the public comment requirements of Section 106 of the NHPA for the proposed Cook Inlet Oil and Gas Lease Sale 244. BOEM will consult with the SHPO regarding subsequent project- and site-specfic activities if they are a type of activity that has the potential to cause effects on historic properties for any proposed exploration, development, and production activities.

APPENDICES

The Draft EIS includes five appendices:

- **Appendix A – Accidental Spills (Oil Spills and Gas Releases; Information, Models, and Estimates)**. 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 E&D Scenario. The rationale for these assumptions is a mixture of project-specific information, modeling results, statistical analysis, three decades of experience modeling hypothetical oil spills, and professional judgment.

- **Appendix B – Very Large Oil Spill (VLOS) Estimate for an Exploration Well in the (Federal) Cook Inlet Planning Area, Alaska.** Appendix B provides modeling results for a hypothetical VLOS resulting from a well blowout in the proposed Lease Sale Area.
- **Appendix C – Air Quality Modeling**. Appendix C provides details and results of air quality modeling performed using the Offshore and Coastal Dispersion (OCD5) model to assess potential air quality impacts from the Proposed Action.
- **Appendix D – Applicable Laws, Regulatory Responsibilities, and Executive Orders**. Appendix D provides a brief summary of those portions of Federal laws, regulations, and executive orders, as they relate directly or indirectly to BOEM management of mineral leasing, or to oil and gas exploration and development, and production activities on the OCS.
- **Appendix E – Estimate of Employment, Population and Fiscal Impacts, OCS Sale 244: Upper Cook Inlet.** Appendix E provides estimates of employment, earnings, and population impacts based on the E&D Scenario. The fiscal impacts to local governments, and the State of Alaska, and Federal Governments are estimated.

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Chapter 1

The Proposed Action

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Chapter 1. PROPOSED ACTION

The U.S. Department of the Interior (USDOI), Bureau of Ocean Energy Management (BOEM) is proposing to conduct an oil and gas lease sale of portions of the outer continental shelf (OCS). Lease Sale 244 would provide qualified bidders the opportunity to bid on OCS blocks in Cook Inlet to gain conditional rights to explore, develop, and produce oil and natural gas. The proposed Lease Sale Area focuses on the northern portion of the Cook Inlet Planning Area (Figure 1-1) and includes 224 OCS blocks which encompass an area of approximately 442,875 hectares (ha) (1.09 million acres (ac)), or about 20% of the Cook Inlet Planning Area. A detailed map of the proposed Lease Sale Area is provided in Chapter 2.

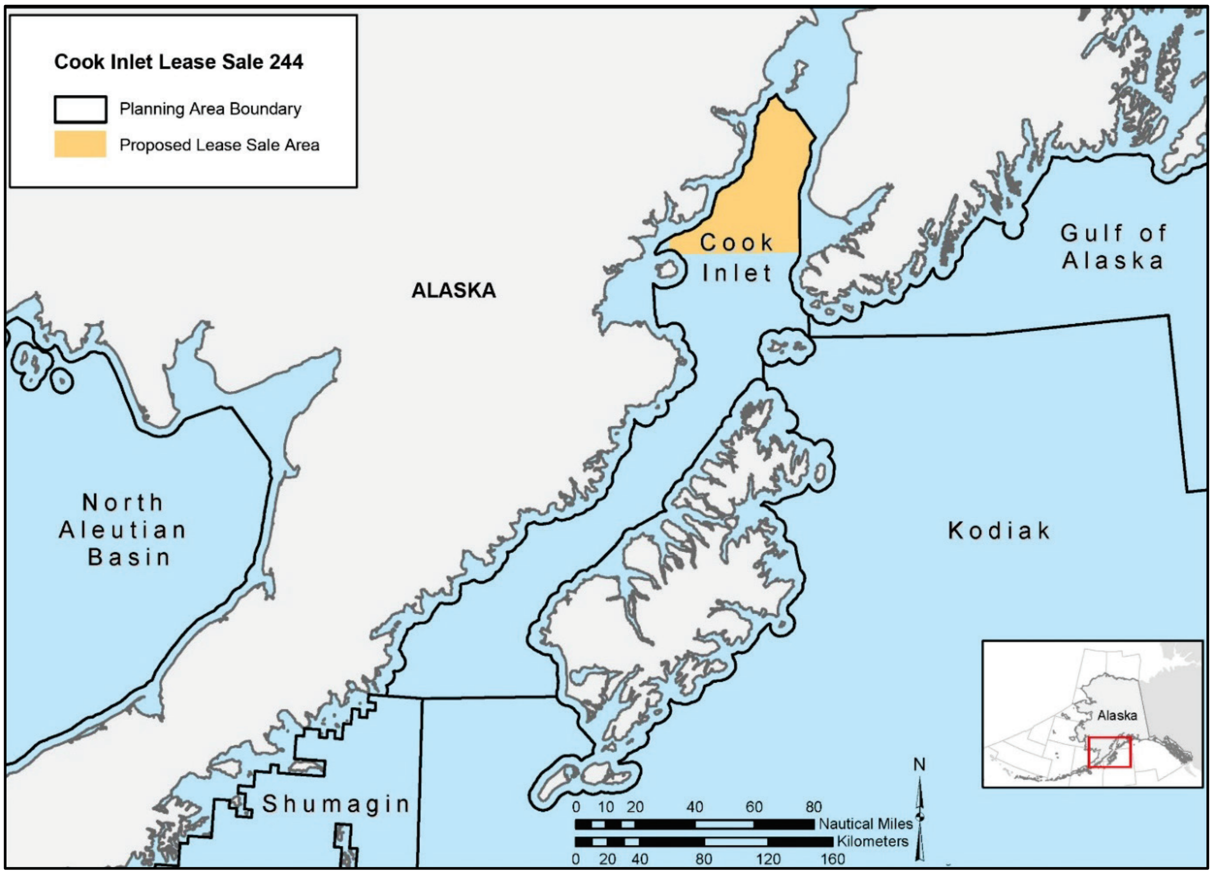

Figure 1-1. Proposed Lease Sale Area for Cook Inlet Lease Sale 244.

1.1. Purpose and Need for the Proposed Action

The purpose of the Proposed Action addressed in this Draft Environmental Impact Statement (EIS) is to offer for lease certain OCS blocks located within the federally-owned portion of Cook Inlet that may contain economically recoverable oil and gas resources.

The need for the Proposed Action is to further the orderly development of OCS resources in accordance with the Outer Continental Shelf Lands Act of 1953 (OCSLA), as amended (43 United States Code [U.S.C.] 1331 *et seq.*). The proposed OCS lease sale in Cook Inlet may lead to oil and gas exploration, development, and production. Oil and gas from the Cook Inlet Planning Area could help meet regional and national energy needs and lessen the need for imports.

The OCSLA 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 OCS. The Secretary of the Interior is charged with developing the Five-Year OCS Oil and Gas Leasing 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 of the Interior 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.

In the most recent (2011) National Resource Assessment, BOEM assigned the Cook Inlet Planning Area (in the most likely case) an undiscovered economically recoverable resource potential of approximately 1.00 billion barrels (Bbbl) of oil and 1.03 trillion cubic feet (Tcf) of gas (USDOI, BOEM, 2011a). These estimates represent volumes that could be economically recovered using current technology. Resource estimates are based on analyses of seismic data, information from exploratory wells, and extrapolation of geologic trends from surrounding onshore and state offshore oil and gas fields. BOEM estimates that an undiscovered economic resource of approximately 215 million barrels (MMbbl) of oil, and 571 billion cubic feet (Bcf) of natural gas in two fields within the Cook Inlet proposed Lease Sale Area could be discovered and developed as a result of Lease Sale 244. Further information about Cook Inlet Planning Area resources and prospects is presented in Section 2.4.

1.2. Background

Extensive exploration and development has occurred in Alaskan state waters of Cook Inlet over the past 40 years, qualifying Cook Inlet as a mature basin (Alaska Department of Natural Resources (ADNR), 2015a). The State of Alaska schedules annual area-wide sales in state waters, the most recent of which was held in May 2015. Existing infrastructure in the upper portion of Cook Inlet includes 17 offshore platforms in state waters, associated oil and gas pipelines, and onshore processing and support facilities (ADNR, 2015a).

There are currently no active OCS leases in Cook Inlet. Five OCS lease sales have been held in the Cook Inlet Planning Area in the past 38 years. In October 1977, Sale CI resulted in 88 leases being issued. In September 1981, Sale 60 resulted in 13 leases being issued. A reoffering sale, Sale RS-2, was held in August 1982, but no bids were received and no leases resulted from this sale. Sale 149, held in June 1997, resulted in two leases being issued. Lease Sale 191 was held in May 2004, and no bids were submitted. Two special interest Cook Inlet Lease Sales, 211 and 219, were scheduled under the 2007-2012 OCS Oil and Gas Leasing Program. On July 8, 2008, the Minerals Management Service (MMS; now BOEM) issued a Request for Interest (RFI) for Cook Inlet Lease Sale 211. MMS received three comments, but no industry nominations identifying specific leasing interest, and decided not to proceed with the lease sale. On March 2, 2011, the decision to cancel Lease Sale 219 was published in the *Federal Register* (76 *Federal Register* (*FR)* 11506, March 2, 2011).

These leasing activities precipitated only a limited degree of oil and gas activities. Between 1978 and 1985, a total of 13 exploratory wells were drilled in the Cook Inlet Planning Area, all of which have been permanently plugged and abandoned. Further information about the exploration history of Cook Inlet is presented in Section 2.4.2. All OCS leases have since expired or been relinquished.

Current proposed Lease Sale 244 was included in the 2012-2017 OCS Oil and Gas Leasing Program (USDOI, BOEM, 2012a), approved by the Secretary of the Interior on August 27, 2012. Prior to approval of the program, Lease Sale 244 was designated as a special interest lease sale.

On March 27, 2012, BOEM issued an RFI for Lease Sale 244 (77 *FR* 18260). Due to the long lead time necessary to prepare for a lease sale, the RFI was issued before the schedule of lease sales for 2012–2017 was approved in August 2012. The RFI sought comments from the oil and gas industry; tribal, local, and state governments; Federal agencies; and the public, to evaluate whether BOEM should proceed with further evaluations of the Cook Inlet Planning Area for a potential lease sale. The public comment period closed on May 1, 2012.

After reviewing comments received in response to the RFI, BOEM issued its Area Identification (Area ID) for Lease Sale 244 on November 27, 2013 (USDOI, BOEM, 2013). The Area ID, which is the proposed Lease Sale Area analyzed in this EIS, comprises 224 OCS blocks in the northern portion of the Cook Inlet Planning Area, close to existing infrastructure needed to support exploration, development and production activities. The proposed Lease Sale Area included most of the areas identified by industry in their responses to the RFI, but excluded from consideration for leasing the critical habitat areas for the Steller sea lion (*Eumetopias jubatus*), as well as the majority of the designated critical habitat areas for the beluga whale and the northern sea otter otherwise encompassed in the larger Planning Area (Figure 1-2). Also excluded from consideration were portions of the Cook Inlet Planning Area near the Katmai National Park and Preserve (NPP), the Kodiak National Wildlife Refuge (NWR), Alaska Peninsula NWR, Becharof NWR, and the Alaska Maritime NWR. The Area ID also excluded many areas used for subsistence by the Native villages of Nanwalek, Port Graham, and Seldovia, as identified during the Cook Inlet Lease Sale 191 process (USDOI, MMS, 2003). By excluding critical habitat, subsistence areas, and areas adjacent to parks, preserves, and wildlife refuges the proposed Lease Sale Area reduced potential effects to those resources.

On October 23, 2014, BOEM published a Notice of Intent (NOI) to prepare an EIS in support of Lease Sale 244 in the *Federal Register* (79 *FR* 63437, October 23, 2014). Publication of the NOI opened a public comment period that extended through December 8, 2014. In November 2014, BOEM held a series of scoping meetings for the EIS. Scoping and other pre-lease processes and activities are discussed further in Section 1.4. Following the publication of this Draft EIS, there will be additional opportunities for public comment as summarized in Chapter 6.

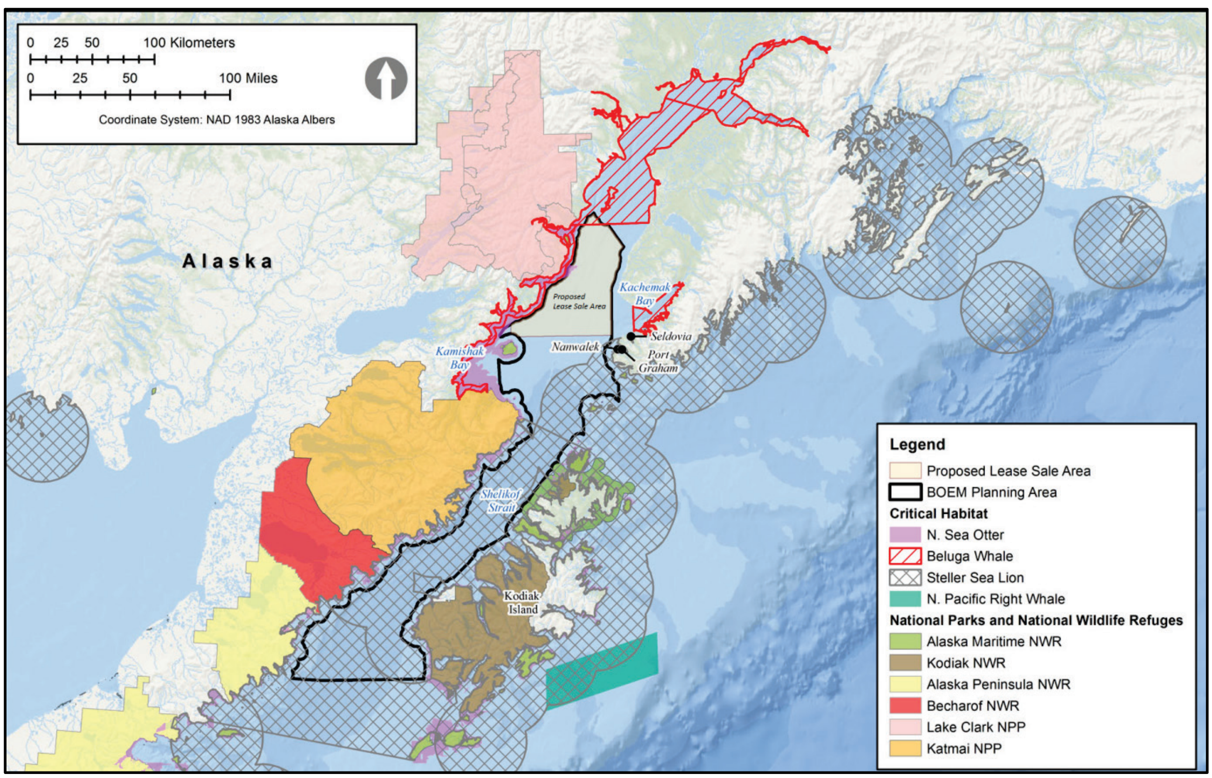

Figure 1-2. Location of the Proposed Lease Sale Area in Relation to Selected Environmental Features.

1.3. Regulatory and Administrative Framework

A number of Federal statutes and their implementing regulations establish the OCS Oil and Gas Leasing Program, the environmental review process, and specific consultation and coordination processes with Federal, state, and local agencies. In addition, the OCS leasing process and all activities and operations on the OCS must comply with other applicable Federal, state, and local government laws and regulations. A brief summary of those portions of Federal laws, regulations, and executive orders, as they relate directly or indirectly to BOEM management of mineral leasing, exploration and development, and production activities on the OCS can be found in Appendix D.

1.3.1. Outer Continental Shelf Lands Act (OCSLA)

The OCSLA establishes Federal jurisdiction over submerged lands on the OCS seaward of state boundaries and provides the framework for OCS oil and gas exploration and development. The basic goals of the OCSLA include the following:

- Establish policies and procedures for managing the oil and natural gas resources of the OCS that are intended to result in expedited exploration and development of the OCS in order to achieve national economic and energy policy goals, assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade
- Preserve, protect, and develop oil and gas resources of the OCS in a manner that is consistent with the need: (a) to make such resources available to meet the Nation's energy needs as rapidly as possible; (b) to balance orderly resource development with protection of the human, marine, and coastal environments; (c) to ensure the public a fair and equitable return on the resources of the OCS; and (d) to preserve and maintain free enterprise competition
- Encourage development of new and improved technology for energy resource production, which will eliminate or minimize risk of damage to the human, marine, and coastal environments
- Ensure that affected states and local governments have timely access to information regarding OCS activities and opportunities to review, comment, and participate in policy and planning decisions

The Secretary of the Interior is responsible under the OCSLA for the administration of mineral exploration and development of the OCS. Within the USDOI, BOEM is charged with the responsibility of managing and regulating the development of OCS resources in accordance with the provisions of the OCSLA, and is charged with conducting OCS lease sales as well as monitoring and mitigating adverse potential impacts that might result from the activities it authorizes. BOEM regulations are at 30 CFR 550 through 556 for oil and gas, 30 CFR 585 for renewable energy, and 30 CFR 580 for minerals other than oil, gas, and sulfur. The Bureau of Safety and Environmental Enforcement (BSEE) is another Federal bureau of USDOI, which has responsibilities on the OCS. BSEE provides environmental compliance support to operations permitted by BOEM under 30 CFR 251. BSEE works to promote safety, protect the environment and conserve resources offshore through regulatory oversight and enforcement.

The OCSLA and BOEM implementing regulations create a four-stage process for leasing, exploration, and development of oil and gas resources in Federal waters (Figure 1-3).

Stage 1 (Develop Five-Year Program): The Secretary of the Interior (through BOEM) prepares a Five-Year OCS Oil and Gas Leasing Program to identify the size, timing, and location of proposed lease sales.

Stage 2 (Planning for Lease Sale): BOEM conducts the pre-lease process and prepares a lease sale-specific National Environmental Policy Act (NEPA) review. If BOEM proceeds with a lease sale, BOEM conducts a sealed-bid auction, evaluates the bids for fair market value, and issues the leases. An OCS lease authorizes a lessee to engage only in ancillary activities that meet BOEM performance standards at 30 CFR 550.202(a), (b), (d), and (e). Lessees must notify BOEM prior to conducting any ancillary activities. BOEM reviews each notice to verify compliance with the aforementioned performance standards, which include a requirement that 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, and 550.209). 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)).

Stage 3 (Exploration): Prior to any exploratory drilling, a lessee must submit an Exploration Plan (EP) to BOEM, which conducts an environmental impacts review under NEPA and a compliance review under its regulations. To be approved, the activities proposed in the EP must meet the performance standards enumerated in 30 CFR 550.202, including the requirement that proposed activities may not cause undue or serious harm or damage to the human, marine, or coastal environment. If the EP is approved, the lessee then must apply for and obtain any additional Federal permits or approvals needed to conduct the activities described in the EP. At this stage of the process, BSEE's responsibilities include reviewing and potentially approving Applications for Permits to Drill (APDs), ensuring that operators have adequately prepared to respond to an oil spill, overseeing and inspecting any exploration drilling operations on the OCS, and exercising its enforcement authority as necessary.

Stage 4 (Development and Production): Development and production is reached only if a lessee finds a commercially viable oil or gas discovery. A lessee must submit a detailed Development and Production Plan (DPP) that BOEM must review under NEPA as well as BOEM regulations. In addition, BOEM uses the criteria in 30 CFR 550.202 to review the plan. At least once in each OCS planning area, such as the Cook Inlet Planning Area, a proposed DPP will be declared a major Federal action for which an EIS will be prepared (43 U.S.C. 1351(e)(1); 30 CFR 550.269(a)). If the DPP is approved, the lessee then must apply to various other Federal agencies for specific permits and/or approvals required for proposed pipelines, platforms, and other infrastructure as described in the DPP. At this stage of the process, BSEE would once again review and potentially approve an APD, ensure that operators have adequately prepared to respond to an oil spill, oversee and inspect any construction, drilling and production operations, and exercise its enforcement authority as necessary.

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

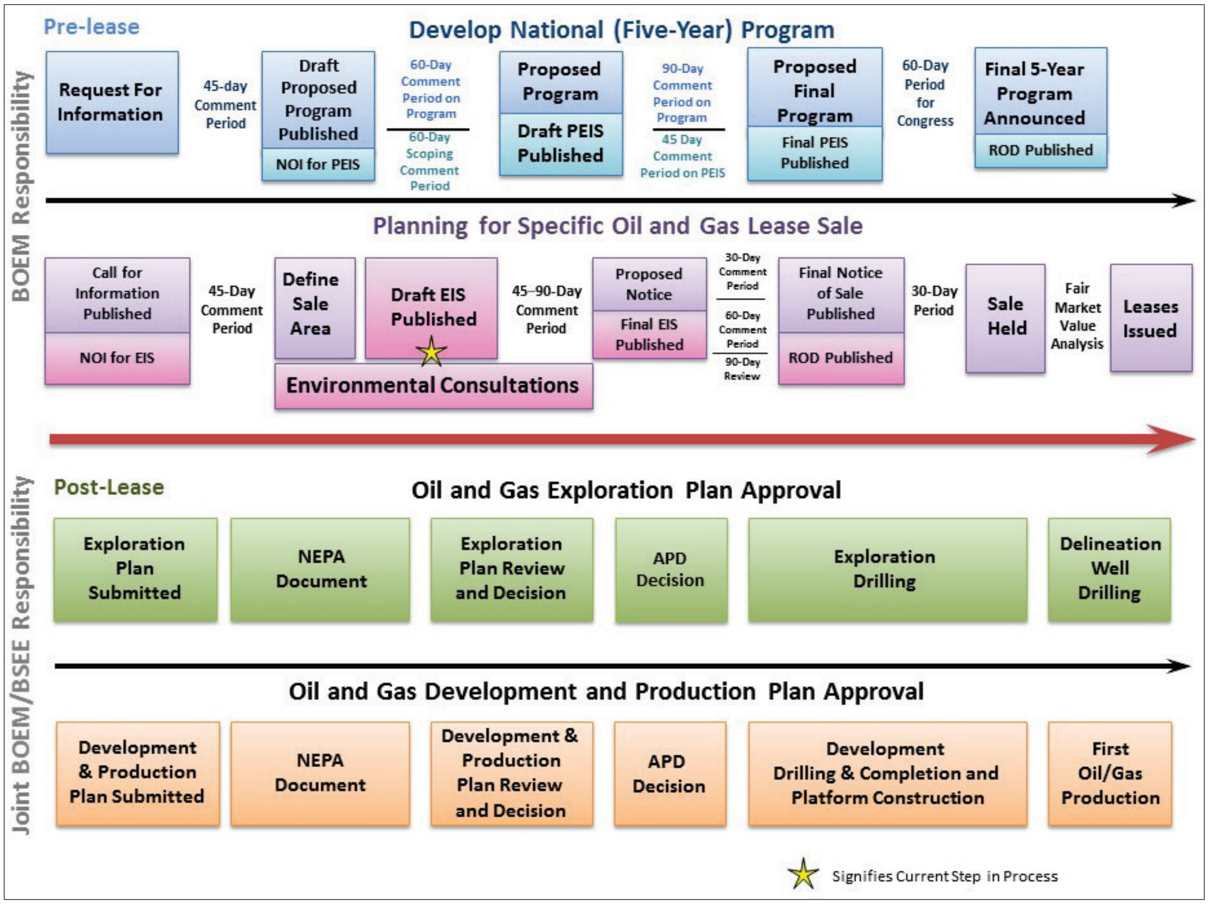

Figure 1-3. Four Stages of the OCSLA Oil and Gas Process.

1.3.2. National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ)

NEPA (42 U.S.C. 4321 *et seq.*) requires Federal agencies to use a systematic, interdisciplinary approach to analyzing the environmental impact of a major Federal action, including the preparation of a detailed EIS. This approach ensures the integrated use of the natural and social sciences in any planning and decision-making for activities that may have an impact on the environment. An EIS must analyze any adverse environmental effects that cannot be avoided or mitigated, alternatives including the Proposed Action and a no action alternative, the relationship between short-term uses and long-term productivity of the environment, and any irreversible and irretrievable commitments of resources. In 1979, the Council on Environmental Quality (CEQ) established uniform procedures for implementing NEPA. These regulations (40 CFR 1500.1 to 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 46.

1.3.3. Land Use and Coastal Management

1.3.3.1. Land Status and Use

The land adjacent to the proposed Lease Sale Area is within the Kenai Peninsula Borough (KPB), a political subdivision of the State of Alaska. Cook Inlet divides the borough into two land masses. The Federal Government is the predominant land owner of onshore lands within the borough, with more than half of the borough’s land area encompassed by the Kenai NWR, the Lake Clark NPP, the Chugach National Forest, and the Katmai NPP. The State of Alaska is also a major landholder within the Kenai Peninsula Borough. The majority of the population in the borough lives on the Kenai Peninsula; land to the west of Cook Inlet is much less populated (U.S. Census Bureau, 2010).

1.3.3.2. Coastal Zone Management

Pursuant to the Coastal Zone Management Act (CZMA) and the Coastal Zone Reauthorization Amendments of 1990, all Federal activities, including OCS oil and gas lease sales and post-lease activities, must be consistent to the maximum extent practicable with the enforceable policies of each affected state's coastal zone management program. The federally-approved Alaska Coastal Management Program expired on June 30, 2011, and the Federal consistency provision no longer applies in Alaska. Consequently, Federal agencies are not required to provide the State of Alaska with CZMA Consistency Determinations pursuant to 16 U.S.C. § 1456(c)(1) and (2), and 15 CFR 930, Subpart C (76 *FR* 39857, July 7, 2011).

1.3.4. Notices and Information Provided to Lessees

To encourage lessees' knowledge and appreciation of operational aspects and environmental resources, inform lessees on how to avoid adverse impacts to these resources, and provide guidance to lessees on how to fulfill the requirements of the OCS operating regulations, BOEM develops and distributes the administrative documents described here.

1.3.4.1. Notice to Lessees and Operators

Notices to Lessees and Operators (NTLs) are formal documents that provide clarification, description, or interpretation of a regulation or an 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 or BSEE 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 OCS regions. National and regional NTLs are posted to BOEM or BSEE's websites. The Alaska NTLs summarized in Section 2.6.2 apply to all OCS activities in Cook Inlet conducted pursuant to Lease Sale 244 and are considered part of the Proposed Action and each action alternative.

1.3.4.2. Information to Lessees and Operators

Information to Lessees and Operators (ITLs) are statements for informational purposes. Some ITLs provide information about issues and concerns related to particular environmental or sociocultural resources. Others explain how lessees might plan their activities to meet BOEM or BSEE requirements or reduce potential impacts. Still other ITLs provide information about the requirements or mitigation required by other Federal and state agencies.

The ITLs summarized in Section 2.6.3 apply to all OCS activities in Cook Inlet conducted pursuant to Lease Sale 244, and are considered part of the Proposed Action and each action alternative.

1.4. Pre-Lease Processes and Activities

USDOI regulatory provisions specific to oil and gas leasing are at 30 CFR 556, 559, and 560. The Area ID decision announced on November 27, 2013, was an administrative pre-lease step that described the geographic area of the Proposed Action (USDOI, BOEM, 2013). The Area ID is the proposed Lease Sale Area analyzed in this Draft EIS. As mandated by NEPA, this Draft EIS analyzes the potential impacts of the Proposed Actions on the marine, coastal, and human environments.

Consultation, Coordination and Public Involvement for Proposed Lease Sales

Scoping for this Draft EIS was conducted in accordance with NEPA, and the regulatory provisions implementing this statute. Scoping provides interested and affected parties an opportunity to comment on the Proposed Action, the scope of the EIS (including the range of actions, alternatives, and impacts to be considered), and the significant issues to be analyzed in depth in the environmental impact statement as well as those issues that can be excluded from the analyses. In addition, scoping gives BOEM an opportunity to update the Alaska OCS Region's environmental and socioeconomic information base.

To begin the EIS scoping process, BOEM published the NOI (October 2014), and additional public notices were distributed via local newspapers, the U.S. Postal Service, and the internet. The NOI served to announce the beginning of the scoping process designed to identify issues and concerns related to the potential lease sale, and announced the schedule for five public scoping meetings that were held at the following locations in 2014:

- November 12 – Seldovia (Tribal Conference Center)
- November 13 – Nanwalek (Tribal Community Center)
- November 13 – Homer (Homer Middle School)
- November 14 – Soldotna (Kenai Peninsula College)
- November 24 – Anchorage (Loussac Library)

All received scoping comments were considered in the preparation of this Draft EIS. Comment topics included impacts to state and national parks, state game refuges, critical habitat areas, and other protected areas; subsistence, impacts to the region's fish and wildlife communities and aquatic food chain, impacts to commercial, sport, and subsistence fisheries, benefits of the Proposed Action to local economies, impacts to area resources and communities from an accidental oil spill, and possible contribution of the project to climate change.

BOEM also conducted early coordination with appropriate Federal and state agencies and other concerned parties to discuss and coordinate the pre-lease process for the proposed lease sale and this Draft EIS. BOEM conducted government-to-government consultations with federally recognized tribes and government-to-corporation consultations with Alaska Native Claims Settlement Act (ANCSA) corporations. A more complete discussion of consultations and agency coordination is in Chapter 6. The National Park Service (NPS) participated as a formal cooperating agency on the Draft EIS. Other key agencies included the Bureau of Safety and Environmental Enforcement (BSEE), the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), U.S. Department of Defense (USDOD), U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (EPA), and the State of Alaska's Governor's office. BOEM will continue to coordinate with other Federal and state agencies throughout the NEPA process.

This Draft EIS will be made available for review during a public comment period. In accordance with 30 CFR 556.26, BOEM will schedule public hearings at locations in communities in the coastal area adjacent to Cook Inlet to receive these comments. BOEM then will develop a Final EIS which will respond to the public comments and revise the document as appropriate. No decision on whether and how to proceed with Lease Sale 244 may be made until at least thirty (30) days after publication of the Final EIS. BOEM will publish a Notice of Availability (NOA) in the *Federal Register* to inform the public of the document release.

The Final EIS is not a decision document. A Record of Decision (ROD) will be prepared with the decision on whether or not to hold proposed Lease Sale 244. The ROD will summarize the Proposed Action and the alternatives evaluated in the Final EIS, the conclusions of the impact analyses, and other information and factors considered in reaching the decision. The Final EIS will identify BOEM's preferred alternative for the lease sale as well as the environmentally preferable alternative, which may be different alternatives.

A Proposed Notice of Sale (NOS) will become available to the public approximately four to five months prior to the proposed lease sale. A NOA for the Proposed NOS will appear in the *Federal Register*, initiating a 60-day comment period. If the decision is to hold the lease sale, comments received will be analyzed during preparation of the decision documents that are the basis for the Final NOS, which describes the lease sale configuration, and terms and conditions.

If the decision, which will be made by the Assistant Secretary of the Interior for Land and Minerals Management, is to hold a proposed lease sale, a Final NOS will be published in the *Federal Register* at least 30 days prior to the lease sale date, as required by the OCSLA.

Geological and Geophysical Exploration Permits

Potential bidders interested in the upcoming sale often collect geological and geophysical (G&G) data for the purpose of identifying prospective areas for leasing in the sale. In accordance with 30 CFR 551, a permit must be obtained from BOEM prior to conducting G&G exploration for mineral resources, except exploration by a lessee on a lease. Upon receiving a G&G permit application, BOEM completes an environmental review in accordance with NEPA and other applicable policies and guidelines.

1.5. Post-Lease Processes and Activities

The following subsections briefly describe several means through which BOEM and BSEE regulate OCS post-lease activities. Additional regulations administered and enforced by agencies other than BOEM and BSEE also apply to OCS activities; that regulatory framework is identified in Section 1.3.

1.5.1. Ancillary Activities

Ancillary activities are defined in 30 CFR 550.105 and regulated by 30 CFR 550.207 to 550.210. Ancillary activities are on-lease activities that are allowed to proceed on the OCS without a separate permit or an approved EP or DPP. Information from ancillary activities (e.g., geohazard and geotechnical surveys) typically is needed to support the submittal of EPs, DPPs, and applications for pipeline rights-of-way. Geohazard (geophysical) survey data are used to identify and characterize conditions at or below the seafloor that are potentially hazardous to infrastructure. The data also are used to locate possible archaeological sites for preservation. Geotechnical (geological) activities are conducted to obtain physical and chemical data on surface and subsurface sediments.

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

1.5.2. Exploration Plans (EPs) and Development and Production Plans (DPPs)

BOEM approval is required prior to any exploration, development, or production activities within an OCS leased block. Lessees seeking to engage in such actions must submit an EP or a DPP, as appropriate, for BOEM review. Proposed plans must describe the proposed activities and also include supporting information such as environmental information, an archaeological report, a biological report, and other environmental data determined necessary. This information includes an analysis of offshore and onshore impacts that may occur as a result of the activities. BOEM reviews supporting information for the occurrence of geohazards, 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 a site- and plan-specific NEPA analysis (typically an Environmental Assessment (EA) for EPs, or an EA or EIS for DPPs), based on available information. 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 to BSEE and obtain approval for an Application for Permit to Drill (APD). The APD must include detailed information about the seafloor and shallow seafloor conditions of the drillsite and 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 and other hazards.

1.5.3. Pipelines

Regulatory authority over pipelines on the OCS and in coastal areas is shared by several Federal agencies, including the USDOI, the U.S. Department of Transportation (USDOT), the U.S. Army Corps of Engineers (USACE), the Federal Energy Regulatory Commission (FERC), and the USCG. The State of Alaska shares regulatory authority for pipelines within 3 nautical miles (nmi) of its shores. State of Alaska standards and regulations also would be applicable when OCS pipelines tie into shore-based facilities, pump stations, or other pipelines when facilities, such as pump stations, or other pipelines located in state-owned waters or tidelands within the 3 nmi state boundary.

BSEE regulations pertaining to pipelines are located at 30 CFR 250.1000 to 1019. Pipeline permit applications to BSEE must contain sufficient design and operational information to allow BSEE to analyze the safety and environmental compliance of the installation. Applications generally contain such elements as design basis and calculations, maps and design schematics, any 3rd-party verification of features to deal with site-specific design challenges, a review of site hazards, and other items. BSEE evaluates the design and fabrication of the pipeline and its compliance with applicable policies and guidelines. All pipeline rights-of-way on the OCS, including those that go ashore, must undergo NEPA review as part of the approval of a DPP. The operators are required to periodically inspect their routes by methods prescribed by the BSEE Regional Supervisor for any indication of pipeline leakage or maintenance issues. 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.

1.5.4. 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 of the Interior 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

1.5.5. BSEE Technical and Safety Review

The lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to ensure 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 generally be equipped with safety devices that would shut off the flow from the well in the event of an emergency. All surface production facilities also must be maintained and operated in a manner that provides for efficiency, safety of operations, and protection of the environment.

1.5.6. Pollution Prevention and Oil-Spill Response

Pollution prevention regulatory requirements for oil, gas, and sulphur operations in the OCS are in 30 CFR 250 Subpart C and 550 Subpart C. The regulations require operators that engage in exploration, development, production, and transportation of oil and gas to prevent unauthorized discharge of pollutants into offshore waters which 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 and, if so, to effect immediate repair.

In compliance with 30 CFR part 254, all owners and operators of oil handling, storage, or 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 for BSEE approval, an OSRP 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 an OSRP. An OSRP must be submitted before an owner/operator may use a facility. To remain in compliance and continue operations, the operator must maintain response preparedness as described in the approved plan, and on a biennial basis conduct a comprehensive review of the OSRP and submit any changes to BSEE for review, or if no changes are required submit written notification stating the review was completed and no changes were made. Revisions to an OSRP must be submitted to BSEE within 15 days whenever any of the following occurs:

- A change occurs that significantly reduces an owner’s/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 OSRP
    - There is a significant change in the appropriate area contingency plans
- In meeting the OSRP regulatory requirements under 30 CFR 254 Subpart C, owners/operators may physically deploy portions of their listed response equipment inventories. These equipment deployment activities would typically occur under the following circumstances:
    - BSEE directs equipment deployments during a government initiated, unannounced exercise (GIUE), or spill drill
    - BSEE directs equipment deployments to determine if the equipment is working properly or as part of a personnel training audit
    - An owner/operator deploys the equipment on their own to satisfy their mandated training and exercise requirements

1.5.7. BSEE Inspection Program

BSEE Alaska OCS Region directs or conducts on-site inspections to verify compliance with lease terms, NTLs, and approved plans and permits as well as to verify that the safety and pollution prevention requirements of regulations are met. The 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 List (USDOI, BSEE, 2015).

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 that limit rotation of 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 generally conducts inspections of existing development and production facilities three to four times a year. Regardless of whether the activity is exploration or development, BSEE generally will 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 to issue an incident of non-compliance (INC), which is a documented and recordable action, when a violation is found, and may shut-in any activity that is not in compliance with regulations or the approved permit, including deactivating a piece of equipment, or shutting down the offshore facility. 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 reason for the INC or the shut-in has been properly corrected.

1.5.8. Structure Removal and Site Clearance

Lessees/operators have one year from the time a lease is terminated to permanently plug and abandon all wells and remove all structures from a leased area (30 CFR 250.1700 to 1754). Prior to removing structures, the operator must provide the following information (30 CFR 250.1727):

- Complete identification of the structure
- Size of the structure (number and size of legs and pilings)
- Removal technique to be used (if explosives are to be used, the amount and type of explosive per charge)
- Number and size of well conductors to be removed and the removal technique

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.

1.5.9. Training Requirements for Offshore Personnel

Proper training is important for ensuring that OCS oil and gas operations are carried out in a manner that emphasizes operational safety, and minimizes the risk of environmental damage. Industry 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; however, it must be demonstrated that personnel understand and properly perform their duties (30 CFR 250.1500 to 1510).

1.5.10. Safety and Environmental Management Systems

BSEE requires companies to develop, implement, and maintain a Safety and Environmental Management System (SEMS) to promote safety and environmental protection. The SEMS identifies, addresses, and manages safety issues, environmental hazards, and impacts during the design, construction, start-up, and operations to be conducted on the OCS. Among other things, the SEMS also ensures that all personnel involved with the program receive appropriate training to perform their assigned duties (30 CFR 250.1900 to 1933).

1.6. Environmental Studies Program

BOEM's Environmental Studies Program (ESP) actively plans, designs, and manages 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 USDOI goals focusing on environmentally sound development of our nation's energy and mineral resources. The ESP is managed to maximize cooperative efforts with other Federal programs involved with marine and coastal environmental research and data collection, including through inter-agency agreements, cooperative agreements, and competitive contracts. BOEM research has been recognized consistently for excellence in effective collaboration through venues such as the USDOI Partners in Conservation Awards, and the National Oceanographic Partnership Program Excellence Awards.

The ESP was initiated by the USDOI in 1974 to support the OCS Oil and Gas Leasing Program. Statutory authorization is derived primarily from the OCSLA, as amended. Section 20 of the OCSLA authorizes the ESP and establishes three general goals:

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 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 1974, BOEM has invested approximately $450 million studying the OCS environment offshore in Alaska, and completed >1,000 technical reports and publications. 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. Examples of some notable BOEM technical reports completed recently include, but are not limited to, the following:

- Loss of Well Control Occurrence and Size Indicators for Alaska OCS (OCS Study BOEM 2014-772)
- Analysis of Benthic Communities on Weathervane Scallop Beds in Shelikof Strait (OCS Study BOEM 2014-669)
- Distribution and Abundance of Harbor Seals in Cook Inlet, Alaska. Task I: Aerial Surveys of Seals Ashore, 2003-2007 (BOEM Report 2012-063). Task II: Assessment of Factors Influencing Harbor Seal Haul-out Behavior Using Remote Time-Lapse Cameras, 2003-2005 (BOEM Report 2012-064), and Task III: Movements, Marine Habitat Use, Diving Behavior, and Population Structure, 2004-2006 (BOEM Report 2012-065)
- Evaluating a Potential Relict Arctic Invertebrate and Algal Community on the West Side of Cook Inlet (OCS Study MMS 2010-005)
- Surface Circulation Radar Mapping in Alaskan Coastal Waters: Beaufort Sea and Cook Inlet (OCS Study MMS 2009-049)
- Seasonality of Boundary Conditions for Cook Inlet, Alaska (OCS Study MMS 2009-041); and
- Synthesis: Three Decades of Research on Socioeconomic Effects Related to Offshore Petroleum Development in Coastal Alaska (OCS Study MMS 2009-006)

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Chapter 2

Alternatives and Exploration and Development Scenario

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Chapter 2. ALTERNATIVES

This chapter explains the alternatives that were identified and analyzed in detail within the EIS. It also summarizes other alternatives that were identified but eliminated from detailed study, along with the reasons for their elimination. BOEM developed the Proposed Action based on a targeted leasing model as explained in Section 2.1 and developed alternatives based in part on public and agency input during the scoping process. Scoping was conducted in accordance with NEPA regulations, and BOEM received numerous recommendations for alternatives and mitigation as summarized in the Scoping Report (USDOI, BOEM, 2015a). BOEM also considered recommendations for alternatives and mitigation measures developed for the 2012-2017 OCS Oil and Gas Leasing Program EIS, as discussed in Section 2.6.4.

2.1. Targeted Leasing

The USDOI's 2012-2017 OCS Oil and Gas Leasing Program introduced a targeted leasing model to the Alaska OCS lease sale process. Targeted leasing identifies areas considered for leasing that have high resource potential and clear indications of industry interest, while appropriately weighing environmental protection and subsistence use needs. The overall goal is to focus oil and gas leasing on the most promising blocks, while protecting important habitats and critical subsistence activities. The result is an Area ID that can be more geographically limited in scope and that may eliminate areas of environmental concern prior to preparation of an EIS.

This targeted leasing model was used to define the Area ID for this proposed Lease Sale. Use of the model in Cook Inlet resulted in a considerable reduction in the Cook Inlet Planning Area included in the Area ID and removed several areas of environmental concern prior to publishing an NOI and proceeding to develop alternatives in this EIS.

For the Cook Inlet Lease Sale 244, the Alaska OCS Region reviewed comments received in response to the RFI published in the Federal Register (77 *FR* 18260; March 27, 2012) pursuant to 30 CFR 556.23(a). On May 18, 2012, the Alaska OCS Region sent a recommendation to BOEM's Chief, Office of Strategic Resources, in a memorandum entitled "Summary of Interest and Information Received on Proposed Cook Inlet Oil and Gas Lease Sale 244 and Recommendations for Lease Sale Schedule and Area Identification." The memorandum recommended that the entire Cook Inlet OCS program area be included in the Area ID for environmental analysis and consideration for leasing in Lease Sale 244. The initial Area ID consisted of approximately 1,093 blocks and covered about 2.16 million hectares (about 5.36 million acres).

However, after the 2012-2017 OCS Oil and Gas Leasing Program became effective on August 27, 2012, the Alaska OCS Region changed its recommendation from an areawide sale to a targeted lease sale. Accordingly, the Alaska OCS Region developed a second Area ID recommendation, which reduced the Area ID to a more compact area in the northern portion of the Cook Inlet OCS Planning Area. It consisted of 229 blocks, covered approximately 477,800 hectares (approximately 1.17 million acres), and retained most of the area explicitly indicated by industry in response to the RFI.

The second Area ID recommendation was then modified again to further protect endangered species. Five additional blocks of northern sea otter critical habitat near Augustine Island were removed from consideration for leasing. The revised area consists of 224 blocks and approximately 442,875 hectares (approximately 1.09 million acres). The Area ID retains marginal portions of northern sea otter critical habitat (7 blocks) and beluga whale critical habitat (10 blocks) as shown in Figure 1-2. The final Area ID, developed in November 2013 (a year prior to scoping), is the proposed Lease Sale Area analyzed in this EIS.

As a result of targeted leasing, the proposed Lease Sale Area:

- Focuses on areas closer to existing infrastructure needed to support exploration activities
- Focuses on areas adjacent to active State of Alaska oil and gas leases
- Avoids the vast majority of the designated critical habitat for the beluga whale and northern sea otter
- Completely avoids the critical habitat for the Steller sea lion
- Reduces effects to national parks, preserves, and wildlife refuges by placing the area considered for leasing away from the Katmai National Park and Preserve (NPP), Kodiak National Wildlife Refuge (NWR), and Alaska Maritime NWR; and
- Excludes much of the subsistence-use area for the Alaska Native villages of Nanwalek and Port Graham that were identified during the Lease Sale 191 process

Additional background on the Area ID process is on BOEM’s website at: http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_244_-_Cook_Inlet/Sale_244_Area_ID.pdf

2.2. Alternatives

This EIS analyzes a range of potential alternatives, such as excluding OCS blocks from the lease sale; inclusion of the OCS blocks with additional mitigation; or inclusion of the OCS blocks with no additional mitigation (the Proposed Action). Alternatives identified for detailed analysis are listed below and summarized in Table 2.2-1. Although the alternatives are analyzed separately in the EIS, the Secretary’s decision could incorporate elements of multiple alternatives.

- **Alternative 1 – The Proposed Action (Lease Sale 244).** This alternative would offer for lease 224 OCS blocks in the northern portion of the Federal waters of Cook Inlet (see Section 2.2.1), subject to potential mitigation as identified in Section 2.6 and various portions of Chapter 4.
- **Alternative 2 – No Action.** Under this alternative, Lease Sale 244 would not occur (see Section 2.2.2).
- **Alternatives 3A, 3B and 3C – Beluga Whale Critical Habitat Exclusion, Mitigation or Nearshore Feeding Areas Mitigation.** Alternatives 3A and 3B would apply to 10 OCS blocks that overlap with critical habitat for the Cook Inlet distinct population segment (DPS) of the beluga whale. The 10 OCS blocks would either be excluded from the lease sale (Alternative 3A) or included with a lease stipulation designed to reduce potential impacts to beluga whale critical habitat (Alternative 3B). Alternative 3C would apply seasonal mitigations to all 224 OCS blocks and additional mitigations to 146 OCS blocks located wholly or partially within 10 miles of major anadromous streams to further reduce potential impacts to beluga whales (see Section 2.2.3).
- **Alternatives 4A and 4B – Northern Sea Otter Critical Habitat Exclusion or Mitigation.** These alternatives would apply to 7 OCS blocks that overlap with critical habitat for the southwest Alaska distinct population segment (DPS) of the northern sea otter. The 7 OCS blocks would either be excluded from the lease sale (Alternative 4A) or included with a lease stipulation designed to reduce potential impacts to northern sea otter critical habitat (Alternative 4B) (see Section 2.2.4).
- **Alternative 5 – Gillnet Fishery Mitigation.** This alternative would apply to 105 OCS blocks north of Anchor Point. It would add a lease stipulation in these blocks designed to reduce the potential for interactions with the drift gillnet fishery (see Section 2.2.5).

- **Alternative 6 – Prohibition of Drilling Discharges.** This alternative would offer the same 224 OCS blocks as Alternative 1 but would prohibit the discharge of all drilling fluids and cuttings into Cook Inlet.

Table 2.2.11. Alternatives Identified for Detailed Analysis.

Alternative	OCS Blocks Included in Lease Sale 244	OCS Blocks Subject to Exclusion or Additional Mitigation	Exclusion or Additional Mitigation in the Affected OCS Blocks[1]
1 – Proposed Action	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac)	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac)	See Section 2.6 for proposed mitigation measures, i.e. lease stipulations commonly included in BOEM Alaska OCS Region proposed lease sales.
2 – No Action	None (no lease sale)	None (no lease sale)	N/A (no lease sale).
3A – Beluga Whale Critical Habitat Exclusion	214 blocks (97.32% of proposed Lease Sale Area) 430,988 ha (1.06 million ac)	10 blocks (2.68% of proposed Lease Sale Area) 11,887 ha (29,372 ac)	Excludes all blocks overlapping with critical habitat for the Cook Inlet DPS of beluga whale.
3B – Beluga Whale Critical Habitat Mitigation	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac)	10 blocks (2.68% of proposed Lease Sale Area) 11,887 ha (29,372 ac)	Prohibits lessees from conducting on-lease seismic surveys or exploration drilling from November 1 to April 1 in the affected blocks. Lessees may request a waiver from or variance to this stipulation at the time of filing an exploration plan with the Regional Supervisor, Leasing and Plans (RSLP). Such requests must specify a commensurate method or methods of protecting the beluga whale critical habitat from impacts associated with proposed exploration activities and provide an analysis of the efficacy of that method or methods.
3C - Beluga Whale Critical Habitat and Nearshore Feeding Areas Mitigation	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac)	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac); from November 1 – April 1 146 blocks (65% of proposed Lease Sale Area) 287,869 ha (711,340 acres)	Prohibits lessees from conducting on-lease marine seismic surveys between November 1 and April 1 in any proposed Lease Sale Area OCS blocks (224 OCS blocks). For blocks within 10 miles of major anadromous streams, lessees are also prohibited from conducting on-lease marine seismic surveys between July 1 and September 30. Lessees may request a waiver from or variance to these stipulations at the time of filing an exploration plan with the RSLP. Such requests must specify a commensurate method or methods of protecting the beluga whales from impacts associated with proposed exploration activities and provide an analysis of the efficacy of that method or methods.
4A – Northern Sea Otter Critical Habitat Exclusion	217 blocks (97.31% of proposed Lease Sale Area) 430,982 ha (1.06 million ac)	7 blocks (2.69% of proposed Lease Sale Area) 11,893 ha (29,388 ac)	Excludes all blocks overlapping with critical habitat for the southwest Alaska DPS of northern sea otter.
4B – Northern Sea Otter Critical Habitat Mitigation	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac)	14 blocks (5.44% of proposed Lease Sale Area) 24,106 ha (59,567 ac)	Prohibits lessees from discharging drilling fluids and cuttings or conducting seafloor-disturbing activities within 1,000 m of the critical habitat in the affected blocks. Lessees may request a waiver from or variance to this stipulation at the time of filing an exploration plan with the RSLP. Such requests must specify a commensurate method or methods of protecting the northern sea otter critical habitat from impacts associated with proposed exploration activities and provide an analysis of the efficacy of that method or methods.

Alternative	OCS Blocks Included in Lease Sale 244	OCS Blocks Subject to Exclusion or Additional Mitigation	Exclusion or Additional Mitigation in the Affected OCS Blocks[1]
5 – Gillnet Fishing Mitigation	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac)	105 blocks (43.37% of proposed Lease Sale Area) 192,068 ha (474,611 ac)	Prohibits lessees from conducting on-lease seismic surveys during the drift gillnetting season (approximately mid-June to mid-August) as designated by applicable ADFG regulations and Emergency Orders. Lessees are advised that the Cook Inlet drift gillnet fishery typically operates on Mondays and Thursdays during the drift gillnetting season. Lessees are required to notify the United Cook Inlet Drift Association (UCIDA) of any temporary or permanent structures to be present during the drift gillnetting season. The RSLP may modify these provisions in the review of exploration plans regarding any change to the drift gillnetting season.
6 – Prohibition of Drilling Discharges	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac)	224 blocks (100% of proposed Lease Sale Area) 442,875 ha (1.09 million ac)	Lessees are prohibited from discharging drilling fluid and cuttings into Cook Inlet, including discharges of drilling fluid and cuttings otherwise authorized under relevant NPDES permits.

Note: [1]Mitigation measures are in addition to the measures established through Federal laws, regulations, and proposed lease stipulations, and the information provided via Notices to Lessees and Operators, and Information to Lessees and Operators.

2.2.1. Alternative 1 – The Proposed Action

The Proposed Action would offer for lease 224 OCS blocks in the northern portion of the Cook Inlet Planning Area (Figure 2.2.1-1). Proposed Lease Sale 244 covers an area of approximately 442,875 ha (1.09 million ac), representing approximately 20% of the total Cook Inlet Planning Area (79 *FR* 63437; October 23, 2014).

Rationale for the Alternative: The Proposed Action was developed in accordance with the targeted leasing model for the Alaska OCS as explained in Section 2.1. The 2012-2017 OCS Oil and Gas Leasing Program included a potential lease sale in the Cook Inlet Planning Area. BOEM developed a targeted lease sale including most of the areas identified by industry in their responses to BOEM's RFI, but excluding certain areas identified by other stakeholders as environmentally sensitive. Among the excluded areas are the critical habitat areas for the Steller sea lion, as well as most of the designated critical habitat areas for the beluga whale and the northern sea otter (Figure 1.2-1) otherwise encompassed in the larger Planning Area. The proposed Lease Sale Area removes from consideration for leasing portions of the Cook Inlet Planning Area near the Katmai NPP, Kodiak NWR, and Alaska Maritime NWR (Figure 1.2-1). The proposed Lease Sale Area also excludes many of the subsistence use areas for the Alaska Native villages of Nanwalek, Port Graham, and Seldovia, as identified during the Cook Inlet Lease Sale 191 process (USDOI, MMS, 2003).

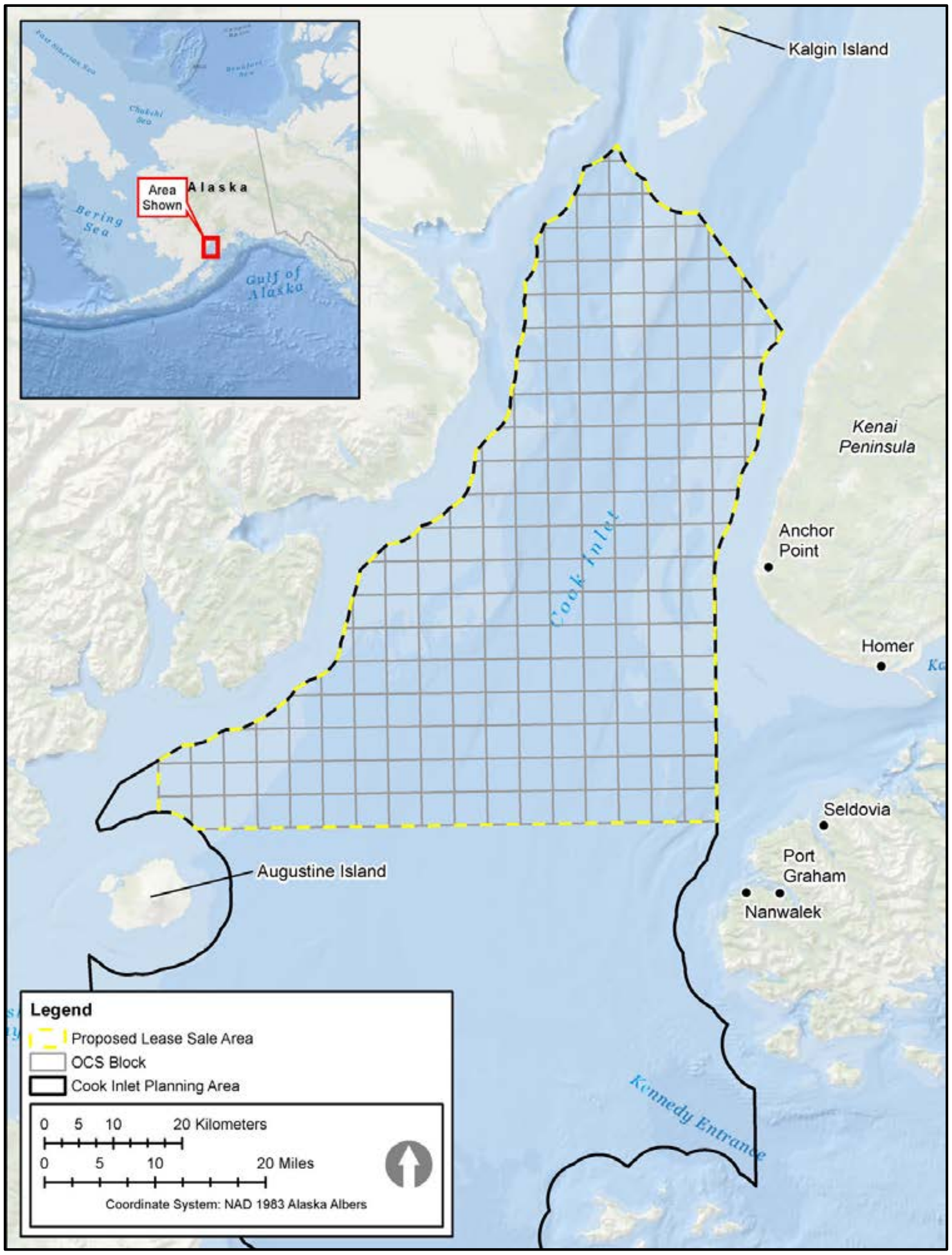

Figure 2.2.1-1. Alternative 1 – The Proposed Action. *Under Alternative 1, Lease Sale 244 would include all 224 OCS Blocks in the proposed Lease Sale Area.*

2.2.2. Alternative 2 – No Action

Alternative 2 is the "No Action" alternative and is equivalent to cancellation of the Proposed Action. Under this alternative, Lease Sale 244 would not occur. The opportunity for development of potential oil and gas resources under the Proposed Action would be precluded or postponed, including any environmental impacts or benefits.

Rationale for the Alternative: Inclusion of the "No Action" alternative is mandated by the CEQ NEPA regulations (40 CFR §1502.14(d)). In addition, not having a lease sale was recommended by many commenters during scoping meetings (USDOI, BOEM, 2015a).

2.2.3. Alternatives 3A, 3B and 3C – Beluga Whale Critical Habitat Exclusion, Critical Habitat Mitigation, and Nearshore Feeding Areas Mitigation

Alternatives 3A, 3B and 3C were developed to address concerns about potential impacts to the Cook Inlet DPS of beluga whales. The following alternatives were identified for detailed evaluations:

Alternative 3A – Beluga Whale Critical Habitat Exclusion. Under this alternative, 214 blocks would be offered for lease. The 10 OCS blocks that overlap with the "Area 2" beluga whale critical habitat at the northern tip of the proposed Lease Sale Area (OPD NP05-08, Blocks 6759, 6760, 6808, 6809, 6810, 6811, 6858, 6859, 6860, and 6861) would be excluded from the lease sale. The areal extent of the affected OCS blocks is 11,997 ha (29,372 ac) or 2.68% of the proposed Lease Sale Area. Beluga whale critical habitat occurring within the excluded OCS blocks represents approximately 0.85% of the total area of the beluga whale critical habitat.

Alternative 3B – Beluga Whale Critical Habitat Mitigation. Under this alternative, 224 blocks would be offered for lease. The 10 OCS blocks that overlap with the "Area 2" beluga whale critical habitat at the northern tip of the proposed Lease Sale Area (OPD NP05-08, Blocks 6759, 6760, 6808, 6809, 6810, 6811, 6858, 6859, 6860, and 6861) would be included in the lease sale with the following Stipulation – Protection of Beluga Whale Critical Habitat:

- Lessees will not conduct on-lease seismic surveys or exploration drilling between November 1 and April 1 when beluga whales are most likely to be present.
- Lessees may request a waiver from or variance to this stipulation at the time of filing an exploration plan with the RSLP and provide the method, and an analysis evaluating the method, of protecting the beluga whale critical habitat from the specified activities in the exploration plan. Such requests must identify alternative methods for providing commensurate protection of beluga whales, and analyze the effectiveness of those methods.

Alternative 3C – Beluga Whale Nearshore Feeding Areas Mitigation. Under this alternative, 224 blocks would be offered for lease with seasonal mitigation to protect beluga whales. Certain seasonal mitigations would be applied to all 224 OCS blocks between November 1 and April 1. Additional mitigation would be applied to the 146 OCS blocks located wholly or partially within 10 miles of major anadromous streams (OPD NO05-01, Blocks 6436, 6484, 6485, 6486, 6532, 6533, 6534, 6535, 6536, 6582, 6583, 6584, 6585, 6586, 6632, 6633, 6634, 6635; OPD NO05-02, Blocks 6006, 6007, 6008, 6009, 6012, 6013, 6014, 6055, 6056, 6057, 6058, 6061, 6062, 6063, 6064, 6105, 6106, 6107, 6108, 6111, 6112, 6113, 6114, 6154, 6155, 6156, 6157, 6161, 6162, 6163, 6202, 6203, 6204, 6205, 6206, 6207, 6210, 6211, 6212, 6213, 6252, 6253, 6254, 6255, 6256, 6260, 6261, 6262, 6263, 6301, 6302, 6303, 6304, 6310, 6311, 6312, 6313, 6351, 6352, 6353, 6354, 6361, 6362, 6363, 6401, 6402, 6403, 6411, 6412, 6413, 6451, 6452, 6453, 6462, 6463, 6501, 6502, 6512, 6551, 6561, 6562, 6610, 6611, 6612; OPD NP05-08 Blocks 6759, 6760, 6708, 6809, 6810, 6811, 6857, 6858, 6859, 6860, 6861, 6862, 6907, 6908, 6909, 6910, 6911, 6912, 6913, 6957, 6958, 6959, 6963, 6964, 7007, 7008, 7009, 7013, 7014, 7015, 7057, 7058, 7059, 7062, 7063, 7064, 7065, 7106, 7107, 7108, 7109, 7112, 7113, 7114). The following Stipulation – Protection of Beluga Whale Critical Habitat and Nearshore Feeding Areas applies to this alternative.

- On all 224 OCS blocks included in the Proposed Action, no on-lease marine seismic surveys will be conducted between November 1 and April 1 when beluga whales are most likely to be present and distributed across the proposed Lease Sale Area.
- For blocks within 10 miles of major anadromous streams, lessees will not conduct on-lease marine seismic surveys between July 1 and September 30 (when beluga whales are migrating to and from their summer feeding areas).

Lessees may request a waiver from or variance to these stipulations at the time of filing an exploration or a development and production plan with the RSLP and provide the method, and an analysis evaluating the method, of protecting the beluga whales from the specified activities in the plan. Such requests must identify alternative methods for providing commensurate protection of beluga whales, and analyze the effectiveness of those methods.

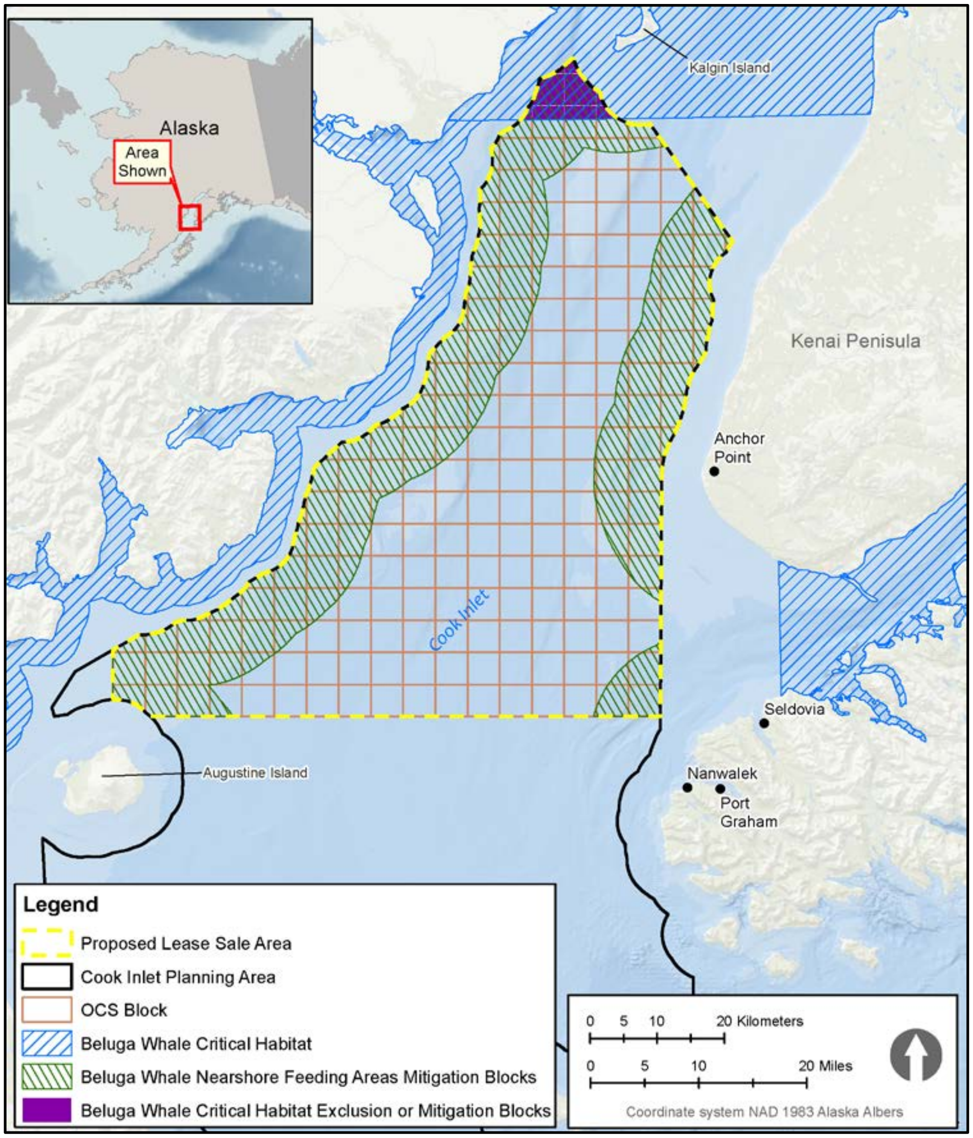

Figure 2.2.3-1. Alternatives 3A, 3B, and 3C – Beluga Whale Critical Habitat Exclusion, Beluga Whale Critical Habitat Mitigation, and Nearshore Feeding Areas Mitigation. *Alternatives 3A and 3B applies to 10 OCS blocks overlapping with critical habitat for the Cook Inlet DPS of beluga whale. Alternative 3A would exclude the 10 blocks from Lease Sale 244. Alternative 3B would include all blocks in Lease Sale 244 with seasonal mitigation applied to the 10 blocks. Alternative 3C applies to146 OCS blocks located wholly or partially within 10 miles of major anadromous streams; certain seasonal mitigations would be applied to all 224 OCS blocks.*

Rationale for the Alternatives: These alternatives were developed to address scoping comments from the NMFS, the Marine Mammal Commission, and others, and to carry forward mitigation recommendations identified by BOEM as part of the 2012-2017 OCS Oil and Gas Leasing Program Mitigation Tracking Table (USDOI, BOEM, 2015b). Alternative 3C was developed during development of this Draft EIS to further address concerns identified in BOEM's ongoing analysis of potential impacts.

The Cook Inlet DPS of the beluga whale was designated as an endangered species in 2008 (73 *FR* 62919, October 22, 2008). Critical habitat was designated for this DPS in 2011 (76 *FR* 20180, April 11, 2011). Designated critical habitat for Cook Inlet belugas is divided into "Area 1" and "Area 2." Area 1, located in the northernmost portions of Cook Inlet, contains shallow tidal flats and river mouths or estuarine areas. These areas are important as foraging and calving areas, may also provide for other biological needs, such as molting or escape from predators, and feature the highest concentrations of beluga whales from spring through fall as well as the greatest potential for adverse impacts from anthropogenic threats. The proposed Lease Sale Area does not overlap with any portions of Area 1 critical habitat. Area 2 critical habitat largely consists of dispersed fall and winter feeding and transit areas in waters where whales typically occur in lower densities, or in deeper waters as compared with "Area 1" critical habitat. The 10 OCS blocks which overlap with Cook Inlet beluga whale critical habitat are all located within Area 2.

Exclusion of the beluga whale critical habitat was identified as an alternative (3A) based on scoping comments from the NMFS, the Marine Mammal Commission, and others. A mitigation alternative (3B) was also developed in which certain activities would be restricted to months when beluga whales are less likely to be present. The mitigation alternative was based on an analysis conducted using the "primary constituent elements" (PCEs) deemed essential to the conservation of the Cook Inlet DPS of beluga whale, as identified in the critical habitat designation (76 *FR* 20180, April 11, 2011).

Of the five PCEs identified in the critical habitat designation, the one with the highest potential for interaction is "waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales." The Draft Recovery Plan for the Cook Inlet DPS of beluga whale identifies anthropogenic noise as a threat of high relative concern (NMFS, 2015a). Seismic surveys, a primary source of underwater sound during OCS oil and gas activities, are not expected to result in "abandonment" of critical habitat, but might result in behavioral responses including temporary avoidance (NMFS, 2015b). These surveys typically are scheduled during the open-water months, but could overlap with the November to April time period when beluga whales are more likely to be present in the critical habitat blocks. Drilling activities are also a source of underwater sound (Richardson et al., 1995). Therefore, Alternative 3B would prohibit on-lease marine seismic surveys and exploration drilling activities from November 1 to April 1.

While not specifically proposed in scoping comments, Alternative 3C was developed by BOEM analysts during preparation of the Draft EIS to further address concerns about potential impacts to beluga whales. In recent IHAs concerning oil and gas activities in Cook Inlet, NMFS required rigorous mitigation measures to achieve the least practicable impacts on Cook Inlet beluga whales and other marine mammals, including restricting activities within 10 mi (16 km) of the Susitna Delta from April 15 through October 15 (NMFS, 2015f). This measure was designed to avoid any effects to belugas in an important feeding and breeding area. Alternative 3C builds on that rationale by expanding the 10 mi restricted area concept to the anadromous streams near the proposed Lease Sale Area that may function as feeding areas for beluga whales.

The criteria that NMFS used to define the buffer size at 10 mi (16 km) was based on modeling data for 1,760 in^3 seismic airgun arrays suggesting noise ≥160 dB travels in a radius of around 5.9 mi (9 km) (80 *FR* 29162, May 20, 2015). The 10 mi area included the estimated 5.9 mi for the airgun array noise to attenuate down to 160 dB (the MMPA Level B Harassment threshold for impulsive sound), plus an additional 4.1 mi buffer to further reduce both the scope and severity of potential impacts to Cook Inlet beluga whales in those areas.

Alternative 3C would prohibit on-lease marine seismic operations between November 1 and April 1, and seismic operations within 10 mi of major anadromous streams near the proposed Lease Sale Area from July 1 through September 30.

Lessees may request a waiver from or variance to this stipulation at the time of filing of an ancillary activities notice, an exploration plan, or development and production plan with the RSLP. Such requests must identify alternative methods for providing commensurate protection of beluga whales, and analyze the effectiveness of those methods. Adaptive management strategies may be proposed by the lessee and authorized by BOEM in the form of a waiver or variance to this stipulation. Based on the analysis submitted by the operator and its independent review of ancillary activity notices, exploration plans, and/or development and production plans, BOEM may allow alternative (and equally effective) means of protection in place of strict compliance with this stipulation.

NMFS may identify additional mitigation measures to protect beluga whales as part of a Biological Opinion developed through Section 7 consultation with BOEM pursuant to the ESA. NMFS may also incorporate additional mitigation measures into any incidental take authorizations (i.e. Letters of Authorization (LOAs) or an Incidental Harassment Authorizations (IHA)) issued pursuant to the MMPA and its implementing regulations.

2.2.4. Alternatives 4A and 4B – Northern Sea Otter SW DPS Critical Habitat Exclusion or Mitigation

Alternative 4A would exclude 7 OCS blocks that overlap with critical habitat for the southwest Alaska DPS of the northern sea otter (Figure 2.2.4-1). Alternative 4B would require additional mitigation in OCS blocks within 1,000 meters of critical habitat for the southwest Alaska DPS of the northern sea otter. These alternatives were developed to address scoping comments, and to carry forward mitigation recommendations identified by BOEM as part of the 2012-2017 OCS Oil and Gas Leasing Program Mitigation Tracking Table (USDOI, BOEM, 2015b).

Six OCS blocks overlap with the northern sea otter critical habitat along the western edge of the proposed Lease Sale Area. One additional OCS block in the north-central portion of the proposed Lease Sale Area also contains a small area of critical habitat (Figure 2.2.4-1). The areal extent of the sea otter critical habitat is 11,893 ha (29,388 ac) or 2.69% of the proposed Lease Sale Area. Critical habitat occurring within the excluded OCS blocks represents approximately 0.23% of the total area of the northern sea otter critical habitat. The following alternatives were identified for detailed evaluation:

Alternative 4A – Northern Sea Otter Critical Habitat Exclusion. Under this alternative, 217 OCS blocks would be offered for lease. The 7 OCS blocks that overlap with northern sea otter SW DPS critical habitat (OPD NO05-02, Blocks 6055, 6056, 6057, 6105, 6106, and 6155; and OPD NP05-08, Block 6911) would be excluded from the lease sale.

Alternative 4B – Northern Sea Otter Critical Habitat Mitigation. Under this alternative, 224 OCS blocks would be offered and the 14 OCS blocks located within 1,000 meters of northern sea otter critical habitat (OPD NO05-01, Blocks 6532, 6533, 6582; OPD NO05-02, Blocks 6007, 6055, 6056, 6057, 6105, 6106, 6154, 6155, and 6156; and OPD NP05-08, Blocks 6911 and 6912) would be included in the lease sale with the following Stipulation – Protection of Northern Sea Otter SW DPS Critical Habitat:

- Lessees are prohibited from discharging drilling fluids and cuttings and conducting seafloor disturbing activities (including anchoring and placement of bottom-founded structures) within 1,000 m of areas designated as northern sea otter critical habitat.
- Lessees may request a waiver from or variance to this stipulation at the time of filing an exploration plan with the RSLP and provide the method, and an analysis evaluating the method,

of protecting the northern sea otter critical habitat from the specified activities in the exploration plan.

Rationale for the Alternative: These alternatives were developed to address scoping comments and to carry forward mitigation recommendations identified by BOEM as part of the 2012-2017 OCS Oil and Gas Leasing Program Mitigation Tracking Table (USDOI, BOEM, 2015b).

The southwest Alaska DPS of the northern sea otter was designated as a threatened species in 2005 (70 *FR* 46366; August 9, 2005). Critical habitat was designated in 2009 (74 *FR* 51988; October 8, 2009). Detailed species information is provided in Section 3.2.3. Other key documents for this species include the Recovery Plan (USFWS, 2013a), and a 5-Year Review: Summary and Evaluation (USFWS, 2013b). Northern sea otters are found in low densities throughout the year in lower Cook Inlet and are not migratory (74 *FR* 51988; October 8, 2009; USFWS, 2013a). The 7 OCS blocks covered under this alternative are within Unit 5 of the designated critical habitat for northern sea otter, which extends along the western shoreline of Cook Inlet northward to Redoubt Point, and from the mean high tide line to the 20-m depth contour (74 *FR* 51988; October 8, 2009).

Exclusion of the northern sea otter critical habitat was identified as an alternative (4A) based on scoping comments. A mitigation alternative (4B) was also developed based on an analysis of PCEs deemed essential to conservation of northern sea otter as identified in the critical habitat designation (Table 2.2.4-1). In particular, this proposed alternative focuses on protecting kelp beds and associated prey resources such as sea urchins from drilling discharges and seafloor-disturbing activities.

Table 2.2.4-1. Southwest Alaska DPS of Northern Sea Otter Critical Habitat Constituent Elements[1].

Primary Constituent Element	Relevance to Lease Sale 244	Potential Mitigation
1. Shallow, rocky areas where marine predators are less likely to forage, which are waters less than 2 m (6.6 ft) in depth	Not relevant to the Proposed Action (all water depths in the proposed Lease Sale Area are > 2 m)	None recommended
2. Nearshore waters that may provide protection or escape from marine predators, which are those within 100 m from the mean high tide line	Not relevant to the Proposed Action (all blocks depths in the proposed Lease Sale Area are ≥3 miles from the mean high tide line)	None recommended
3. Kelp forests that provide protection from marine predators, which occur in waters < 20 m (66 ft) in depth	This habitat type may occur within critical habitat blocks OPD NO05-02, Blocks 6055, 6056, 6057, 6105, 6106, and 6155; and OPD NP05-08, Block 6911	Drilling discharges and seafloor-disturbing activities could be prohibited in water depths < 20 m (66 ft) within critical habitat blocks
4. Prey resources within the areas identified by PCEs 1, 2, and 3 that are present in sufficient quantity and quality to support the energetic requirements of the species	Prey resources associated with kelp forests may occur within critical habitat blocks OPD NO05-02, Blocks 6055, 6056, 6057, 6105, 6106, and 6155; and OPD NP05-08, Block 6911	Drilling discharges and seafloor-disturbing activities could be prohibited in water depths < 20 m (66 ft) within critical habitat blocks

Note: Primary Constituent Elements Identified in the Critical Habitat Designation for the Southwest Alaska Distinct Population Segment of Northern Sea Otter (74 *FR* 51988; October 8, 2009)

Of the PCEs identified in the critical habitat designation, the one with the highest potential for interaction is "[k]elp forests that provide protection from marine predators, which occur in waters less than 20 m (65.6 ft) in depth." Benthic habitat in the proposed Lease Sale Area is soft-bottomed and does not provide kelp habitat. However, certain oil and gas activities (i.e. drilling discharges and placement of bottom-founded structures such as mobile offshore drilling units (MODUs), platforms, and pipelines) could cause localized habitat impacts to kelp forests in nearby areas. Most of the fluid and cuttings discharged during drilling of an OCS well are deposited within approximately 1,000 m of a wellsite (Neff, 2010). Therefore, Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities including anchoring and placement of bottom-founded structures within 1,000 m of areas designated as northern sea otter critical habitat within the affected OCS blocks. Lessees may request a waiver from or variance to this stipulation at the time of filing an exploration plan with the RSLP and provide the method, and an analysis evaluating the method, of protecting the sea otter critical habitat from the specified activities in the exploration plan. With this analysis by the lessee, adaptive management may be considered for a waiver from or variance to this stipulation. During review of exploration and development and production plans, BOEM may require other timing or spatial restrictions, or other mitigation to protect critical habitat.

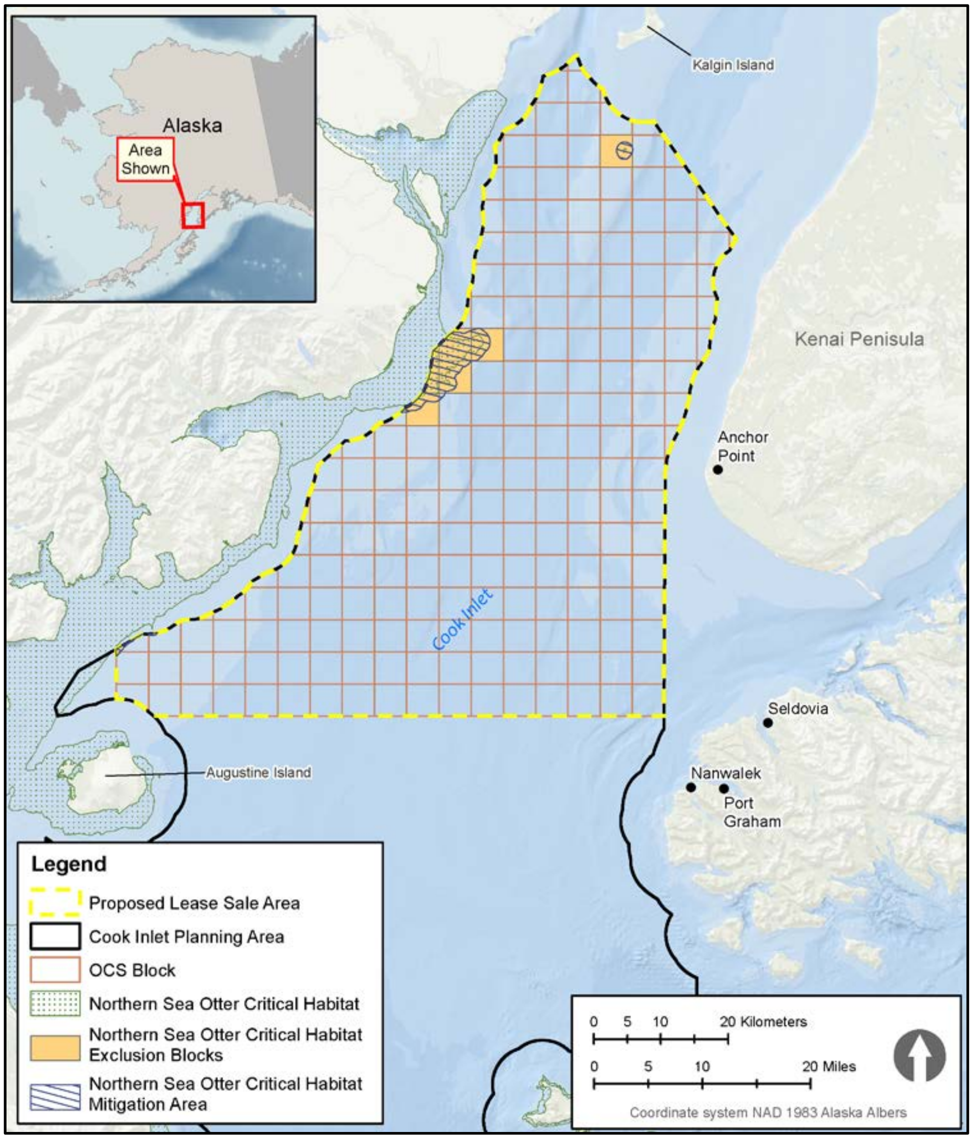

Figure 2.2.4-1. Alternatives 4A and 4B – Northern Sea Otter Critical Habitat Exclusion or Mitigation. *Alternative 4A would apply to 7 OCS blocks overlapping with critical habitat for the southwest Alaska distinct population segment (DPS) of northern sea otter. Alternative 4A would exclude the 7 blocks from Lease Sale 244. Alternative 4B applies to 14 OCS blocks located wholly or partially within 1,000 meters of northern sea otter critical habitat. Alternative 4B would include all blocks in Lease Sale 244; certain mitigations would be applied to 14 blocks.*

NMFS may identify additional mitigation measures to protect northern sea otters as part of a Biological Opinion developed through Section 7 consultation with BOEM pursuant to the ESA. NMFS may also incorporate additional mitigation measures into any incidental take authorizations (i.e. Letters of Authorization (LOAs) or an Incidental Harassment Authorizations (IHA)) issued pursuant to the MMPA and its implementing regulations.

2.2.5. Alternative 5 – Gillnet Fishery Mitigation

Under Alternative 5, 224 OCS blocks would be offered for lease, but additional mitigation measures would be required in all OCS blocks north of Anchor Point to reduce the potential for conflicts with the Cook Inlet drift gillnet fishery. This alternative would affect 117, whole or partial, OCS blocks with an area of 203,932 ha (503,928 ac) or 46.05% of the proposed Lease Sale Area (Figure 2.2.5-1). All OCS blocks north of Anchor Point would be subject to the following Stipulation – Protection of Gillnet Fishery:

- Lessees will not conduct on-lease seismic surveys during the drift gillnetting season as designated by the ADFG (approximately mid-June to mid-August).
- Lessees are advised that the Cook Inlet drift gillnet fishery typically operates on Mondays and Thursdays during the drift gillnetting season as designated by the ADFG. Lessees are required to notify the UCIDA of any temporary or permanent structures planned during the drift gillnetting season. Lessees are encouraged to coordinate with the UCIDA to avoid conflicts. This provision may be modified by the RSLP based on any changes made by the ADFG to the drift gillnetting season.
- Lessees may request a waiver from or variance to this stipulation at the time of filing an exploration plan with the RSLP. Such requests must specify a commensurate method or methods of protecting the gillnet fishery from impacts associated with proposed exploration activities and provide an analysis of the efficacy of that method or methods.

Rationale for the Alternative: As discussed in Section 3.3.2, the Cook Inlet gillnet fishery operates primarily north of Anchor Point (Petterson and Glazier, 2004). The drift gillnetting season for salmon extends from mid-June to mid-August, with activities limited to Mondays and Thursdays from 7 a.m. to 7 p.m. Therefore, mitigation in this alternative focuses on timing restrictions for certain activities to prevent or reduce the potential for interactions with drift gillnetting vessels. The potential for impacts would also be reduced by requiring lessees to notify the local drift gillnet fishing organization (UCIDA) of any temporary or permanent structures planned during the drift gillnetting season and by encouraging lessees to coordinate with UCIDA to avoid conflicts. The mitigation includes adaptive management, allowing the RSLP to modify the timing restrictions as needed. BOEM also considered an exclusion alternative for this area, but it was not carried forward for detailed analysis (see Section 2.3.4 for explanation).

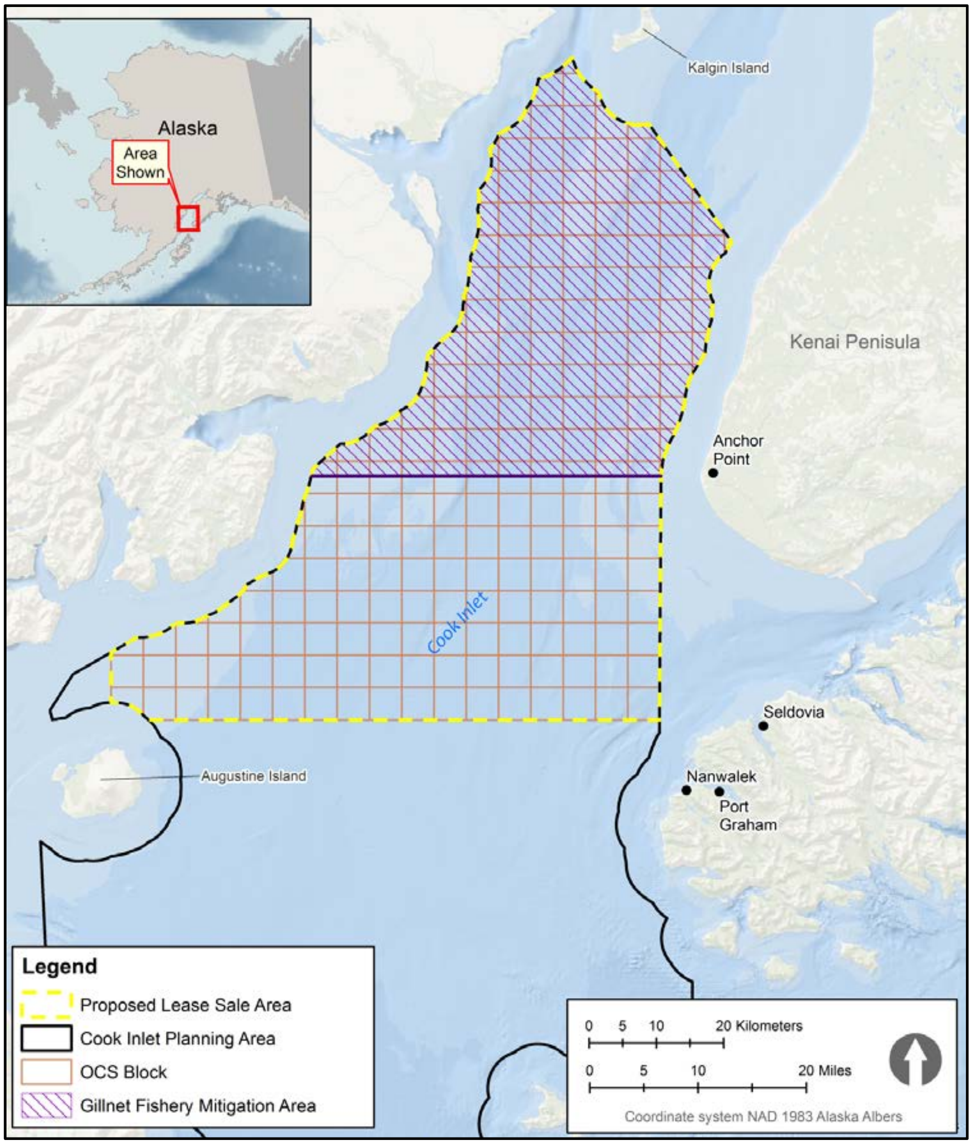

Figure 2.2.5-1. Alternative 5 – Gillnet Fishery Mitigation. *Under Alternative 5, Lease Sale 244 would include all of the blocks in the proposed Lease Sale Area, but a stipulation would apply to all blocks north of Anchor Point to mitigate potential impacts on the drift gillnet fishery.*

2.2.6. Alternative 6 – Prohibition of Drilling Discharges

Alternative 6 would offer the same 224 OCS blocks for lease as the Proposed Action, but all lessees would be prohibited from discharging drilling fluid and cuttings into Cook Inlet. This alternative would permanently prohibit the discharge of all drilling fluid and cuttings on the seafloor with respect to any leases issued as a result of Lease Sale 244. As discussed in Section 2.4, BOEM estimates that 7 to 10 exploration wells could be drilled in the proposed Lease Sale Area, with each well generating approximately 435 tons of water-based fluids and 747 tons of cuttings. Under Alternative 1, these fluids and cuttings could be discharged at each wellsite (to the extent allowed by applicable EPA-issued NPDES permits), but under Alternative 6 they would be transported to shore for land-based disposal.

Rationale for the Alternative: The purpose of this alternative is to eliminate all impacts of drilling discharges to the marine environment. The Proposed Action (Alternative 1) already assumes that all drilling fluid and cuttings from development drilling would be transported to shore because the most recent NPDES general permit (AKG 31-5000) for Cook Inlet OCS development and production facilities prohibits drilling discharges from new facilities. However, the Proposed Action would allow drilling discharges during exploration in accordance with the current NPDES general permit (AKG 28-5100) for exploration facilities, which was issued in July 2015 with an effective date of September 1, 2016. Alternative 6 would prohibit all drilling discharges on leases issued as a result of Lease Sale 244, regardless of whether or not such discharges would be allowed under any current or future NPDES general permit. No other types of discharges authorized under the NPDES would be affected by this alternative.

2.3. Alternatives Considered but not Analyzed in Detail

The following alternatives were considered by BOEM but were eliminated from detailed analysis in the EIS. The CEQ NEPA regulations require that alternatives eliminated from detailed study be presented along with a brief discussion explaining why they were eliminated (40 CFR 1502.14(a)).

2.3.1. Postpone Lease Sale

This alternative would postpone Lease Sale 244. Several commenters recommended this alternative during the scoping process. Although the rationale varied, a general theme was that postponing the lease sale would allow more time to gather additional information to evaluate impacts and ensure the protection of Cook Inlet resources. BOEM determined that this alternative is equivalent to the No Action alternative for purposes of evaluating potential impacts. This alternative would not meet the purpose and need for the Proposed Action and therefore was not analyzed in detail.

2.3.2. Allow Only Gas Exploration and Development

Several commenters recommended during the scoping process that exploration and development in the Lease Sale 244 area be limited to gas, with no exploration and development of oil. However, Section 8 of the OCSLA (43 USC 1337(b)(4)) expressly provides that an oil and gas lease will "entitle the lessee to explore, develop, and produce the oil and gas contained within the lease area, conditioned upon due diligence requirements and the approval of the development and production plan required by the Act." There is no statutory provision authorizing the USDOI to limit OCS lessees to exploration, development, and production of gas only. In addition, it is not technically possible to explore exclusively for gas. An operator cannot know whether a reservoir will produce gas only, until a well is drilled.

2.3.3. Directional Drilling

The alternative of directional drilling from shore was suggested during scoping meetings. Under this alternative, drilling would be conducted from onshore locations to avoid or reduce impacts to OCS resources. In the past, this method was used in the Cosmopolitan Unit north of Anchor Point, where directional wells were drilled from an onshore pad to access subsurface oil and gas formations located approximately 4.0 km (2.5 mi) offshore (Alaska Department of Natural Resources (ADNR), 2015b). BlueCrest Energy is proposing to use a similar approach in developing the Cosmopolitan field in Cook Inlet in 2016. Directional drilling has also been used in the North Sea, Gulf of Mexico, and South China Sea as well as the Milne Point, Badami, Point McIntyre, Alpine, and Niakuk fields in Alaska (Judzis, Jardaneh, and Bowes, 1997).

Although directional drilling could be considered by BOEM in specific cases as part of the NEPA evaluation of an exploration or development and production plan, it is not feasible as a lease sale alternative here, where the vast majority of the proposed Lease Sale Area is beyond the limit of directional drilling technology, and where geologic conditions are not necessarily conducive to safe and effective directional drilling. The maximum horizontal distance achieved by extended-reach drilling is approximately 12 km (7.6 mi) (Rosneft, 2015). The maximum distance reported by Rosneft (2015) was achieved in an area (Sakhalin Island, Russia) where the geology is conducive to drilling extended reach wells, unlike the Cook Inlet area. Wells of this nature would be very high risk in the Cook Inlet due to the highly complex nature of the geology and the presence of coal seams that could squeeze (flow) into the wellbore, trapping the drill stem. Moreover, all OCS blocks are at least 4.8 km (3.0 mi) from the nearest shoreline, and only 20.42% of the proposed Lease Sale Area is within 12 km (7.6 mi) from shore. A directional drilling alternative would not meet the purpose and need for the Proposed Action because at least 80% of the proposed Lease Sale Area would not be accessible. In addition, some OCS blocks within this range might require an onshore drillsite to be located in an inaccessible or protected area such as Lake Clark NPP.

2.3.4. Northern Area Exclusion

This alternative would exclude all OCS blocks north of Anchor Point as recommended by the Marine Mammal Commission and other scoping commenters. This alternative would remove 105 OCS blocks and reduce the proposed Lease Sale Area by 192,068.4 ha (474,611.3 ac), or 43.37%. The objective would be to reduce the potential for interactions with the drift gillnet fishery that operates seasonally in this area (Petterson and Glazier, 2004), and also reduce the possibility of interactions and impacts with beluga whales, which are more likely to be found in the northern part of the proposed Lease Sale Area (NMFS, 2008; Ferguson, Curtis, and Harrison, 2015).

BOEM determined that this alternative would not meet the purpose and need of Lease Sale 244 due to the relatively high industry interest in this area and the large percentage of the proposed Lease Sale Area that would be excluded. In addition, the goals of this alternative are addressed by the lease stipulations proposed under the Proposed Action as well as the various measures proposed under Alternatives 3A (Beluga Whale Critical Habitat Exclusion); 3B (Beluga Whale Critical Habitat Mitigation); and 3C (Beluga Whale Critical Habitat and Nearshore Feeding Areas Mitigation), which are specifically tailored to addressing potential impacts to beluga whales. The goal of reducing impacts on the gillnet fishery is addressed by Alternative 5 (Gillnet Fishery Mitigation).

2.3.5. Lower Kenai Peninsula Exclusion

The Lease Sale 191 EIS included two exclusions, Lower Kenai Peninsula and Barren Islands, intended in part to reduce conflicts between subsistence users and OCS oil and gas operations (USDOI, MMS, 2003). The Barren Islands exclusion area has been avoided through the Area ID process and targeted leasing approach; it is entirely outside the boundaries of the proposed Lease Sale Area and is not considered further.

The Lower Kenai Peninsula exclusion area in the Lease Sale 191 EIS consisted of 34 whole or partial OCS blocks offshore Port Graham, Nanwalek, Seldovia, and the tip of the lower Kenai Peninsula. Through the Area ID process and targeted leasing approach, most of these OCS blocks are already excluded from the Proposed Action. Only nine of the OCS blocks included in the Lease Sale 191 Lower Kenai Peninsula exclusion are within the proposed Lease Sale Area.

Subsistence uses and harvest patterns are discussed in detail in Section 3.3.3. Subsistence uses in OCS waters offshore the Lower Kenai Peninsula are inherently seasonal and BOEM expects that potential conflicts can be avoided through other mitigation included in the Proposed Action. Therefore, a Lower Kenai Peninsula exclusion was not evaluated in detail for this EIS. Two relevant proposed lease stipulations that would help to reduce conflicts with subsistence uses are discussed in Section 2.6.1. Lease Stipulation No. 1 requires exploration and development and production operations to be conducted in a manner that avoids unreasonable conflicts with the fishing community including subsistence users (see Section 2.6.1). Each lessee is required to review planned exploration and development with directly affected fishing organizations, subsistence communities, and port authorities to avoid unreasonable fishing gear conflicts. Local communities, including fishing interests, will have the opportunity to review and comment on proposed EPs and DPPs as part of the BOEM regulatory review process. The comments will be considered during BOEM’s decision to approve, disapprove, or require modification of the plan. Lease Stipulation No. 3 requires lessees to include an orientation program in their EPs and DPPs to inform individuals working on the project of specific environmental, social, and cultural concerns that relate to the area that could be affected by the operation or its employees. The program would increase the sensitivity and understanding of personnel to community values, customs, and way of life in project areas and would include information concerning avoidance of conflicts with subsistence uses. These stipulations are expected to be effective in avoiding and/or reducing impacts on subsistence uses, and therefore a Lower Kenai exclusion alternative was not evaluated in detail.

2.3.6. Exclusion of Areas near National Park Service Units

During scoping, the NPS submitted a comment recommending that BOEM exclude or place additional mitigation on OCS blocks near National Park Service (NPS) units. BOEM has already addressed this recommendation through its targeted leasing approach by reducing the program area to the northern portion of the Cook Inlet Planning Area as shown in Figure 1-2. The Area ID reduced potential effects to NPS units by excluding the area adjacent to the Katmai NPP. The nearest NPS unit to the proposed Lease Sale Area is Lake Clark NPP. BOEM considered further exclusion as proposed by NPS, but did not identify an alternative to be evaluated in detail because: (1) all OCS blocks included in the proposed Lease Sale Area are already greater than 3 miles from Lake Clark NPP; (2) routine OCS activities are not expected to have substantial impacts on Lake Clark NPP; (3) no shore bases, pipeline landfalls, or other onshore facilities would be located in or near the NPP; and (4) providing a buffer zone would not necessarily minimize or prevent impacts from accidental spills. In considering whether to analyze a buffer or exclusion alternative, BOEM also reviewed a recent state exploration license covering areas between the proposed Lease Sale Area and Lake Clark NPP, which includes no specific mitigation, buffers, or exclusions tied to the NPP (ADNR, 2014a). Further, three other alternatives (3A, 3C, and 4A) already carried forward for evaluation in this EIS would exclude certain OCS blocks along the northern and western edge of the proposed Lease Sale Area near Lake Clark NPP. Therefore, impacts to Lake Clark NPP, as well as those impacts avoided if lease blocks near the park are excluded, are already considered in existing alternatives carried forward for analysis.

2.3.7. Tankering Oil and Gas

Tankering of OCS oil and gas was considered by BOEM but not carried forward for full analysis in this EIS. The smallest crude oil tankers carry about 300,000 barrels of oil and are typically used for long-distance transport. Using massive vessels to transport oil from the platforms in Cook Inlet to the oil refinery sixty miles south of Anchorage would be expensive and impractical. If tanker loadouts were delayed, production shut downs would be required if platform storage vessels were full. For over 50 years, oil produced in Cook Inlet state waters has been transported by pipeline and provides a historical economic model for likely development. Meanwhile, natural gas cannot be tankered unless it is first transported to a plant and compressed and cooled to liquefied natural gas (LNG). Therefore, the only way to transport produced gas from the platforms to the Kenai LNG plant is by pipeline.

The current Cook Inlet natural gas and oil production is used to meet the needs of Southcentral Alaska. The E&D scenario predicts that the additional production which would result from Lease Sale 244 would also be consumed in Southcentral Alaska, where local demand generates a higher price for natural gas than in the rest of the United States.

2.4. Exploration and Development Scenario

Exploration and Development (E&D) Scenarios are conceptual views of the future and represent reasonably possible, though not necessarily probable, sets of activities. The E&D Scenario is a fundamental first step for an environmental analysis of the potential environmental effects from oil and gas activities as a result of leasing including the successful development of oil and gas production. An E&D Scenario is based upon BOEM's professional judgment of the interpreted geologic features within the area offered for lease coupled with an analysis of current exploration and production activities. It is only one possible view of how the potential resources could be developed if they are found. An E&D Scenario is not a permitting document for any OCS activity. It simply provides a reasonable, possible set of activities to frame an environmental analysis and to inform decision-makers of potential environmental effects of offering certain areas for leasing.

2.4.1. Proposed Cook Inlet OCS Oil and Gas Lease Sale 244

Pursuant to the Submerged Lands Act, OCS waters begin 3 nautical miles from the shoreline of the State of Alaska. The Cook Inlet Planning Area comprises the waters west of the Kenai Peninsula extending south through Shelikof Strait, bordered by the Alaska Peninsula to the west and Kodiak Island to the east (Figure 2.4.1-1). The most likely case in BOEM's 2011 National Resource Assessment assigns the Cook Inlet Planning Area an undiscovered economic recoverable resource (UERR) potential of approximately 1.00 billion barrels (Bbbl) of oil and 1.03 trillion cubic feet (Tcf) of gas, based upon a price pair of $110/bbl for oil and $7.83/thousand cubic feet (Mcf) for gas. These are volumes which could conceivably be economically recovered using current technology. Resource estimates are based on seismic data, information obtained from 13 exploratory wells, and extrapolation of geologic trends from surrounding onshore and state offshore oil and gas fields.

Unlike other Alaska OCS planning areas, the Cook Inlet Planning Area has a nearby market for both oil and gas. Cook Inlet gas has become a valuable commodity to be used locally or potentially transported as liquefied natural gas (LNG). As a result, the current E&D Scenario does not defer gas sales until oil production is depleted. The existing natural gas distribution system in south-central Alaska could be extended to transport gas from the Cook Inlet OCS to the greater Anchorage and Kenai Peninsula areas. Despite the abundance of oil and gas in Alaska, energy is expensive because of transportation costs and lack of infrastructure. Because there is no pipeline tying Alaska gas to the gas distribution system in the contiguous 48 states, Alaska's natural gas price is based on the local market. The local market is conditioned to support a higher wellhead price of gas than the trading market, or Henry Hub price. For example, the July 2014 Alaska price was $5.69/Mcf; the Henry Hub price for the same period was $4.05/Mcf. Furthermore, the prevailing value for Cook Inlet gas from 2011 to 2014 has averaged approximately $6.00/Mcf, rising to $6.11 in the fourth quarter of 2014 (Alaska Department of Revenue, 2014). Cook Inlet gas exports to Japan resumed in the spring of 2014 after an export hiatus through most of 2013 (Petroleum News Alaska (PNA), 2014a). Current market contract LNG price for delivery in Japan was $13.86/Mcf at the end of November 2014 (Ycharts, 2014).

The proposed Lease Sale 244 area is confined to the northernmost part of the planning area, as shown in Figure 2.2.1-1. The southern boundary of the proposed Lease Sale 244 area is located along the Seldovia Arch. This arch marks the southern margin of the Cook Inlet Basin. BOEM estimates that an undiscovered economic resource of approximately 215 MMbbl of oil and 571 billion cubic feet (Bcf) of natural gas in two fields within the proposed Lease Sale Area could be discovered and developed as a result of Lease Sale 244. These two hypothetical developments would produce resources equal to 22% of the estimated oil and 74% of the estimated gas in the most likely case of the Undiscovered Economically Recoverable Resources in the entire Cook Inlet OCS Planning Area at $100/bbl for oil (2016 Resource Assessment). In 2015, crude oil prices dropped below $50/bbl. This E&D Scenario details the first oil production as a result of Lease Sale 244 in year 2022 (assuming no delays of any kind). Since oil prices fluctuate, BOEM relies upon the UERR price point published in the most recent Resource Assessment, in this case dated 2016 (USDOI, BOEM, 2016).

There are four stages in this E&D Scenario:

1. Exploration
2. Development
3. Production
4. Decommissioning

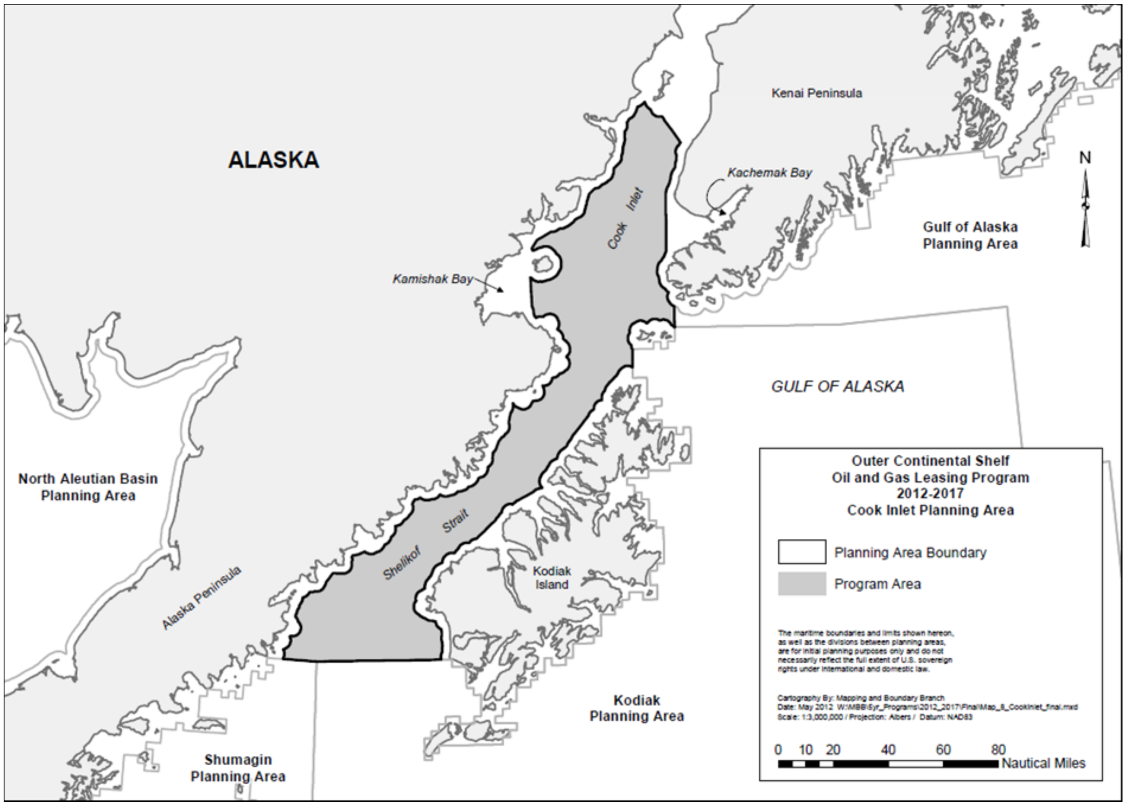

Figure 2.4.1-1. Cook Inlet Planning Area.

2.4.2. Exploration History

All the developed oil and gas fields in the Cook Inlet Basin to date are in State of Alaska waters or onshore. Richfield Oil Corporation discovered the first oil field at Swanson River on the Kenai Peninsula in 1957. Oil production began in 1959, along with a small amount of gas as a by-product. Unocal discovered the first significant gas field at Kenai in 1959, and production began in 1961. Pan American Oil Corp. discovered the first offshore oil field at Middle Ground Shoal in 1962. Offshore oil production began in 1967. Amoco discovered the first offshore gas field at North Cook Inlet in 1962, and production began in 1969. Thirteen offshore platforms are currently active in Upper Cook Inlet; the latest was installed in 2015 by Furie Operating LLC at the Kitchen Lights Field.

From 1966 to 2005, operators collected approximately 192,000 line miles of pre-lease, deep-penetration seismic data which were used by BOEM and companies to evaluate the geologic potential for oil and gas resources and possible hydrocarbon prospects.

The first OCS well drilled in Lower Cook Inlet was the ARCO COST (Continental Offshore Stratigraphic Test) well in 1977. The first Federal lease sale, OCS Sale CI, was held that year, and 87 tracts were leased. The second lease sale, OCS Sale 60, was held in 1981, and 13 tracts were leased. The last OCS Cook Inlet Lease Sale, Lease Sale 149, was held in 1997, and two tracts were leased. Lease Sale 191, which was scheduled in 2004, included preparation of an environmental impact statement and proposed and final notices of sale; the sale was not held because industry failed to submit any bids.

From 1978 through 1985, 13 exploratory wells were drilled to test 10 prospects in Lower Cook Inlet, representing over 15% of the exploration wells drilled in the Alaska OCS Planning Area (Table 2.4.2-1). Three of those wells were abandoned at shallow depths because of drilling problems and were re-drilled at approximately the same locations. All the wells were plugged and abandoned with no discoveries announced. Two wells had significant oil shows in Late Cretaceous strata. Both wells, the Marathon Y-0086 well and the ARCO Y-0097 well, tested non-commercial oil with very low flow-rates in drill stem tests. The Chevron Y-0243 well had minor oil shows, but was not tested.

In 2005 ConocoPhillips and Pioneer Natural Resources partnered to conduct a three-dimensional (3D) seismic survey over the Cosmopolitan Prospect. Pioneer subsequently acquired a 100% interest. In 2011 Pioneer relinquished all but two state leases in the Cosmopolitan prospect; those leases were ultimately picked up by Buccaneer in partnership with BlueCrest Alaska Operating LLC (BlueCrest) (PNA, 2014b). In 2014 Buccaneer sold its interests in Cosmopolitan to BlueCrest. The State of Alaska received a Lease Plan of Operations application from BlueCrest on June 1, 2015. The proposed plan includes drilling and production operations for the development of the Cosmopolitan Field (BlueCrest, 2015).

Table 2.4.2-1. Exploration History of the Alaska OCS.

Alaska OCS Planning Area	Exploration Wells	Development Wells
Chukchi Sea	6	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	85	7

Note: Includes only OCS wells to total depth, not COST wells.

2.4.3. Prospects

Cook Inlet is part of a large forearc basin (region between an ocean trench and the associated volcanic arc) that lies between the Aleutian Trench and the active volcanic arc on the Alaska Peninsula. The southeastern boundary of the basin is the Border Ranges fault, which separates the sedimentary basin from the metamorphic rocks of a large accretionary complex exposed in the Chugach and Kenai Mountains. The northwestern boundary of the basin is the Bruin Bay fault, which separates the basin from igneous rocks of the Alaska-Aleutian Range batholith exposed on the Alaska Peninsula. The basin-bounding faults and most of the subsurface structural features trend northeast-southwest parallel to the axis of the basin. The Augustine-Seldovia Arch, which is oriented east-west transverse to the main structural trend, separates the forearc basin into two depocenters (location of the deepest deposit in a sedimentary basin). The Lease Sale 244 area and proposed hypothetical developments that could result from leasing are located in the northern depocenter, near the existing commercial fields of the northern Cook Inlet.

Within the boundaries of the area proposed for Cook Inlet Lease Sale 244, BOEM geoscientists and engineers estimate that the Tertiary oil and gas plays will be the main attraction for bids because of their proven petroleum potential in the northern part of the Cook Inlet Basin and their past performance in hosting commercial oil and gas fields. The largest undiscovered pools are considered to represent legitimate proxies for oil and gas pools that might be discovered and developed as a consequence of proposed Lease Sale 244.

The E&D Scenario covers the major activities associated with an active oil lease ranging from preliminary seismic activities to facility decommissioning. One of the primary assumptions in the

E&D Scenario is that sufficient information from marine seismic surveys has been obtained prior to the lease sale to provide prospective lessees sufficient information to form their bids. If the interested parties have not gathered sufficient information for the areas of interest, they may be reluctant to bid during the lease sale. It is also assumed that any resulting exploration will be successful, allowing for analysis based on production of hydrocarbons from the proposed lease sale. Installation of and production from a fixed platform is expected to follow 5 years after the first successful exploration well is confirmed. Based upon estimated well production profiles, production activities from these oil and gas resources in the proposed Lease Sale Area have an estimated duration of approximately 33 years.

Productivity information used to forecast production from these potential prospects was extracted from play analysis of data based upon local wells, seismic mapping, and historical production data from analog fields. These data are used to forecast individual well-stream models coupled with well-installation scheduling to develop/forecast the field-wide production from the field development scenario. Production rates are used to size the pipelines between platforms and to shore-based facilities. Assumed pipeline lengths are based upon distances from hypothetical developments to existing or expected new infrastructure. Prospects found in the southern portion of the identified proposed Lease Sale 244 area are assumed to join in with infrastructure associated with the development of the Cosmopolitan Field. Prospects found in the northern portion of the proposed Lease Sale Area are assumed to tie-in with existing infrastructure in Nikiski.

In the E&D Scenario, an oil field and a gas field are assumed to be discovered and developed. To produce the estimated 215 MMbbl of oil, and 571 Bcf of natural gas, three 24-slot platforms will be required, from which 66 wells (production and service) are to be drilled. The E&D Scenario assumes separate platforms and production wells are required to produce from each prospect. To maximize the well numbers for the environmental analysis, this scenario assumes that wells are not repurposed. Natural gas associated with oil production would be separated and sold to the local distribution market. This has been the approach to development of offshore oil fields in state of Alaska waters in northern Cook Inlet (see tabulations of service well types, Alaska Oil and Gas Conservation Commission, 2004 and Alaska Division of Oil and Gas, 2009, table I.6), where associated gas is marketed and borehole pressure maintained via water injection.

Table 2.4.3-1 shows the schedule for the E&D Scenario. There are no delays in the E&D Scenario timeframe associated with approval of the development plans due to regulatory issues or litigation.

Table 2.4.3-1. Schedule for the E&D Scenario.

Exploration and Development Scenario Schedule Cook Inlet Lease Sale 244			
Activity	**Beginning Year**	**Ending Year**	**Total Years**
Perform Marine Seismic Surveys	1	2	2
Perform Geohazard Surveys	1	3	3
Perform Geotechnical Surveys	1	3	3
Drill Exploration and Delineation Wells	2	5	4
Install Platforms	7	10	4
Drill Production and Service Wells	7	13	7
Install Onshore Oil Pipeline	6	6	1
Install Onshore Gas Pipeline	6	6	1
Install Offshore Oil Pipelines	6	9	2
Install Offshore Gas Pipelines	6	9	3
Oil Production	7	34	28
Gas Production	7	39	33
Decommissioning	35	40	6

Table 2.4.3-2 shows the exploration and development activities E&D Scenario projected for the Cook Inlet Lease Area under Lease Sale 244.

Table 2.4.3-2. Exploration and Development Activities Projected Under the E&D Scenario.

Scenario Results for Development of Cook Inlet Lease 244 Prospects		
Element	**Range**	**Comment**
Marine Seismic Surveys	1-2	Will vary within the range based on number of operators
Geohazard Surveys	4-5	Will vary within the range based on number of operators
Geotechnical Surveys	4-5	Will vary within the range based on number of operators
Platforms	2-3	Will vary within the range based on number of operators and overlying prospects.
Exploration and Delineation Wells	7-10	Includes dry holes and additional unsuccessful wells from other Cook Inlet OCS prospects
Production Wells	55-66	Depends on ability to have multiple completions in overlaying oil producing strata
Service Wells	10-12	15-23% of production wells
Onshore Oil Pipeline (miles)	50	Longer distance may be required for rerouting
Onshore Gas Pipeline (miles)	50	Longer distance may be required for rerouting
Offshore Oil Pipeline (miles)	60-85	Miles vary within the range based on location of actual prospects
Offshore Gas Pipeline (miles)	60-115	Miles vary within the range based on location of actual prospects
Total Oil Production (MMbbl)	150-215	
Total Gas Production (Bcf)	81-571	
Peak Oil Rate (Mbbl/day)	68	
Peak Gas Rate (MMcf/day)	181	
New Pipelines to shore	2	1 oil export line, followed by 1 gas export line in same corridor between Homer and Nikiski
New Shore Base	0	Not required, existing infrastructure is adequate
New Processing Facility	0	Not required, existing infrastructure is adequate
New Drilling and Production Waste Handling Facility	0	
Drilling fluids from exploration and delineation wells (tons)	3,045 – 4,350	Estimated at 435 tons/well
Rock cuttings discharge for exploration and delineation wells (tons)	5,229 – 7,470	Estimated at 747 tons/well. Cuttings volume assumes the normal practice of drilling exploration wells significantly deeper than the target formation.
Drilling fluids from service and production wells (tons)	6,318 – 18,954	Estimated at 486 tons/well. Drilling fluids will be disposed of in service wells or barged to shore based upon a material reuse of 50% – 80%.
Rock cuttings from production and service wells (tons)	54,535 – 65,442	Estimated at 839 tons/well – disposed of in service wells or barged to shore. Although these wells are deviated, they are generally not drilled much below the target formation.
Flights per week during exploration drilling	7-21	1 to 3 flights daily per MODU while on location
Boat trips per week during exploration drilling	1-2	1 to 2 trips weekly per MODU during exploration drilling
Flights per week during development phase	21-63	1 to 3 flights per platform per day
Boat trips per week during development phase	3-9	1 to 3 trips per platform per week
Flights per week during production phase	21-63	1 to 3 flights per platform per day
Boat trips per week during production phase	3-6	1 to 2 trips per platform per week
Years of Activity	36-39	Final gas production may be truncated for economic reasons

Notes: MMbbl – Million barrels; Mbbl – thousand barrels; Bcf – Billion cubic ft; MMcf – Million cubic ft; tons – US (short).

2.4.4. Exploration Activities

Seismic Surveys

The E&D model considers two types of seismic surveys: 1) Marine seismic surveys, which generally cover a larger area of leased and/or unleased acreage and 2) Geohazard surveys, which will include side-scan sonar and shallow-penetrating reflection-seismic profiling conducted on a more specific site to detect archeological resources or seafloor features that might be problematic for operations, such as drilling a well or installing a platform or pipeline. Geohazard surveys are often accompanied by geotechnical surveys, which involve sampling or measuring mechanical properties or stability of near-seafloor sediments.

Marine Seismic Surveys

Lessees will use marine seismic survey data to determine the optimal location for drilling the first well on their lease acreage. Deep penetration seismic surveys are the primary tool used to identify prospective locations to drill for subsurface deposits of crude oil and natural gas. Recording, processing, and interpreting reflected seismic waves created by introducing controlled source energy (such as seismic airgun impulses or vibratory waves) into the earth provides a means to identify rock structures that may form traps for petroleum migrating upwards from thermal generation centers.

BOEM assumes that two marine seismic surveys could be conducted during the first 2 years of the E&D Scenario. The most likely support base for seismic exploration would be Kenai/Nikiski or Homer. Marine seismic surveys are anticipated to be 3D surveys focused on clusters of leased tracts offering detailed geologic data for locating exploration wells. New widespread regional seismic surveys will probably not be conducted.

The two-dimensional (2D) and three-dimensional (3D) marine seismic surveys use similar survey methods but different operational configurations. Generally, 3D survey lines are spaced in a grid pattern concentrated in a specific area of interest. These surveys provide the resolution needed for detailed geological evaluation. For a 2D survey, lines are spaced farther apart in a regional pattern that provides less detailed geological information. These surveys are used to cover wider areas to map geologic structures on a regional scale. For both 3D and 2D surveys, the sound source array typically consists of two to three subarrays of six to nine airguns each.

An energy source (e.g. airgun, water gun, or marine vibrator) is used to transmit energy into the subsurface and generate seismic waves. Seismic waves reflect and refract off subsurface strata and travel back to acoustic receivers, called hydrophones. The characteristics of the reflected seismic waves, such as travel time and intensity, are used to evaluate geologic structures, subsurface deposits, and natural resources to help facilitate the location of prospective drilling targets. The acoustic receivers may be towed streamers which consist of multiple hydrophone elements normally towed behind the vessel or ocean bottom nodes (OBN) that are placed on the seafloor. The OBN contains the geophone and data storage which is downloaded when the string of OBNs are retrieved. Biodegradable liquid paraffin is used to fill the streamer and provide buoyancy. Solid/gel streamers also are available for use and are rapidly becoming the industry standard.

Airguns are the typical acoustic sound source for 2D and 3D deep penetration seismic surveys. An outgoing sound signal is created by releasing a high-pressure air pulse from the airguns into the water to produce an air-filled cavity (a bubble) that expands and contracts. The size of individual airguns can range from tens to several hundred cubic inches (in^3). A group of airguns is usually deployed in an array to produce a more downward-focused sound signal. Airgun array volumes for both 2D and 3D seismic surveys are expected to range from 1,800 to 5,000 in^3, but may range up to 6,000 in^3. The energy output of the array is determined more by the number of guns than by the total array volume (Fontana, 2003, pers. commun.). The airguns are fired at short, regular intervals, so the arrays emit pulsed rather than continuous sound. While most of the energy is focused downward and the short duration of each pulse limits the total energy into the water column, the sound can propagate horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994).

The sound-source level (zero-to-peak) associated with typical marine seismic surveys ranges between 233 and 255 decibels re 1 microPascal at 1 meter (dB re 1 μPa @ 1 m) with most of the energy emitted between 10 and 120 hertz (Hz). Vessel transit speeds are highly variable, ranging from 8-20 kn (14.8 to 37.0 kilometers (km)/hour) depending on a number of factors including, but not limited to, the vessel itself, sea state, and urgency (the need to run at top speed versus normal cruising speed). Marine 3D surveys are acquired at typical vessel speeds of approximately 4.5 kn (8.3 km/hour). The source array is triggered approximately every 10-15 seconds (s), depending on vessel speed. The timing between shots varies and is determined by the spacing required to meet the geological objectives of the survey; typical spacing is either 25 or 37.5 m (82 or 123 ft), but may vary depending on the design and objectives of the survey. Airguns can be fired between 20 and 70 times per km.

Marine deep penetration towed-streamer 3D seismic surveys will vary depending on client specifications, subsurface geology, water depth, and target reservoir(s). Individual survey parameters may vary from the descriptions presented here. The vessels conducting these surveys generally are 70 to 120 m (230 to 394 ft) long. Vessels tow one to three source arrays of six to nine airguns each, depending on the survey design specifications required for the geologic target. Most operations use a single source vessel. However, more than one source vessel will be used when using smaller vessels that cannot provide a large enough platform for the total seismic airgun array necessary to obtain target depth. The overall energy output for the permitted activity will be the same, but the firing of the source arrays on the individual vessels will be alternated. The receiver streamer arrays for a 3D survey would include multiple (possible range 4 to 12) streamer-receiver cables towed behind the source array.

The 3D survey data are acquired along pre-plotted track lines within a specific survey area. Adjacent track lines for a 3D survey are generally spaced parallel to each other several hundred meters apart. The areal extent of the equipment limits both the turning speed and the area a vessel covers. It is, therefore, common practice to acquire data using an offset racetrack pattern, whereby the next acquisition line is several km away from, and traversed in the opposite direction of, the track line just completed. Seismic vessels operate day and night, and a survey may continue for days, weeks, or months, depending on the size of the survey, data-acquisition capabilities of the vessel, and weather conditions. Vessel operation time includes not only data collection, but also deployment and retrieval of gear, line turns between survey lines, equipment repair, and other planned or unplanned operations.

The 2D seismic survey vessels generally are smaller than 3D survey vessels; larger 3D survey vessels are also able to conduct 2D surveys. The source array typically consists of three or more sub-arrays of six to nine airgun sources each, but may vary as newer technology is developed. Only one streamer is towed during 2D operations. Seismic vessels acquiring 2D data are able to acquire data at 4 to 5 kn (7.4 to 9.3 km/hour) and collect between 137 and 177 line km (85 and 110 line miles) per day, depending on the distance between line changes, weather conditions, and downtime for equipment problems.

OBN seismic surveys are used in Cook Inlet primarily to acquire seismic data in transitional zones where water is too shallow for a seismic survey vessel and/or where the tides, as in Cook Inlet, make 3D acquisition with streamers very difficult due to problems keeping the streamer straight in the tidal currents. The OBN seismic survey requires the use of multiple vessels. A typical survey includes: (a) two vessels for cable or node layout/pickup; (b) one vessel for recording; (c) one or two source vessels; and (d) possibly one to three smaller (10 to 15 m (33-49 ft)) utility boats. It is unlikely that helicopters may be used for vessel support and crew changes if there are no safety concerns. An additional support vessel may be used to monitor for marine mammals ahead of the survey vessel. OBN seismic source arrays are smaller in size than the towed marine streamer arrays when the survey occurs in the shallower water depths in which OBN surveys are often conducted.

An OBN operation begins by deploying nodes off the back of the layout boat. Line length typically is 4 to 8 km (2.5 to 5 mi) but can be up to 12 km (7.5 mi). Lines of nodes are attached to the rope in intervals typically of 40 to 60 m (131 to 197 ft). Multiple lines of nodes are laid on the seafloor parallel to each other, with a spacing of between hundreds of meters to several kilometers, depending on the geophysical objective of the seismic survey. When the lines are in place, a vessel towing the source array passes over the nodes with the source being activated every 25 or 37.5 m (82 or 123 ft). The source array may be a single or array of multiple airguns, which is similar to the 2D and 3D marine seismic surveys.

Geohazard Surveys

Prior to submitting an exploration plan or development and production plan, oil and gas industry operators are required to evaluate any potential geological hazards and document any potential cultural resources or benthic communities pursuant to 30 CFR 550. Geohazard surveys are conducted as ancillary activities on an oil and gas lease. The survey data are used to identify shallow hazards such as old pipelines or wrecks; obtain engineering data for placement of structures (e.g., proposed platform locations and pipeline routes); and detect subsurface geologic hazards (e.g., faults and gas pockets), archaeological resources, and certain types of benthic communities. BOEM has provided guidelines in Notices to Lessees (NTLs) 05-A01, 05-A02, and 05-A03 that require collection of high-resolution shallow hazards surveys to ensure safe conduct and operations in the OCS at drill sites and along pipeline corridors, unless the operator can demonstrate that there is sufficient existing data to evaluate the site.

The suite of equipment used during a typical shallow hazards survey consists of single beam and multibeam echosounders, which provide water depths and seafloor morphology; a side scan sonar that provides acoustic images of the seafloor; a subbottom profiler which provides 20 to 200 m (66 to 656 ft) sub-seafloor penetration with a 6- to 20-centimeter (cm) (2.4- to 7.9-inch (in)) resolution; a bubble pulser or boomer with 40 to 600 m (131 to 1,969 ft) sub-seafloor penetration; and a multichannel seismic system with 1,000 to 2,000 m (3,280 to 6,562 ft) sub-seafloor penetration. Magnetometers, to detect ferrous items, have not been required in the Alaska OCS to date. Typical acoustic characteristics of these sources are summarized in Richardson et al. (1995) as follows:

- Echosounders: 180 to 200 dB re 1 µPa @ 1 m between 12 and 60 kilohertz (kHz)
- Side scan sonar: 220 to 230 dB re 1 µPa @ 1 m between 50 and 500 kHz
- Subbottom profiler: 200 to 230 dB re 1 µPa @ 1 m between 400 Hz and 30 kHz
- Bubble pulser or boomer: 200 dB re 1 µPa @ 1 m below 1 kHz

The echosounders and subbottom profilers are generally hull-mounted. All other equipment is usually towed behind the vessel. The towed multichannel seismic system consists of an acoustic source which may be a single small airgun 10 to 65 in^3 (0.16 to 1.1 liters) or an array of small airguns usually two or four 10 in^3 (0.16 liter) guns. The source array is towed about 3 m (9.8 ft) behind the vessel with a firing interval of approximately 12.5 m (41 ft) or every 7 to 8 seconds. A single 300 to 600 m (984 to 1,969 ft), 12 to 48 channel streamer with a 12.5 m (41 ft) hydrophone spacing and tail buoy is the passive receiver for the reflected seismic waves.

The ship travels at 3-4.5 kn (5.6-8.3 km/hour). These survey ships are designed to reduce vessel noise, as the higher frequencies used in high-resolution work are easily masked by the vessel noise if special attention is not paid to keeping the ships quiet. Surveys are site specific and can cover less than one lease block, but the survey extent is determined by the number of potential drill sites in an area. BOEM guidelines at NTL-A01 require data to be gathered on a 150 by 300 m (492 by 984 ft) grid within 600 m (1,969 ft) of the surface location of the drill site, a 300 by 600 m (984 by1,969 ft) grid along the wellbore path out to 1,200 m (3,937 ft) beyond the surface projection of the conductor casing, and extending an additional 1,200 m beyond that limit with a 1,200 by 1,200 m grid out to 2,400 m (7,874 ft) from the well site.

A single vertical well site survey will collect about 46 line-miles (74 line-km) of data per site and take approximately 24 hours. If there is a high probability of archeological resources, the 150 by 300 m (492 by 984 ft) grid must extend to 1,200 m (3,937 ft) from the drill site.

Geotechnical Surveys

Geotechnical surveys are conducted to collect bottom samples to obtain physical and chemical data on surface and near sub-surface sediments. Sediment samples typically are collected using a gravity/piston corer, grab sampler, or dredge sampler. Shallow coring (0.3 to 152 m depth (1 to 500 ft)), using conventional rotary drilling from a boat or drilling barge, is another method used to collect physical and chemical data on sub-surface geology.

Exploration and Delineation Drilling

Operators will drill exploratory wells based on mapping of subsurface structures using 2D and 3D deep-penetration seismic data and historical well information. Prior to drilling exploration wells, operators will examine the proposed exploration drilling locations for geologic hazards, archeological features, and biological populations using geohazard seismic surveys and geotechnical studies. Site clearance and other studies required for exploration will normally be conducted the season before the drill rig is mobilized to the site.

Exploration drilling operations are likely to employ Mobile Offshore Drilling Units (MODUs). Examples of MODUs include drillships, semisubmersibles, and jack-up rigs. Drilling operations in Cook Inlet are expected to range between 30 and 60 days per well at different well sites, depending on the depth of the well, delays during drilling, and time needed for well logging and testing operations.

Based upon the expected water depths in the proposed Lease Sale 244 area and recent exploration activities, it is likely that a jack-up rig or drillship will be employed for exploration drilling. BOEM estimates three wells per drilling rig could be drilled, tested, and plugged during a single drilling season using one MODU. The lower Cook Inlet area is a high use area in the summer with an active commercial and recreational fishery and a nearby known beluga whale habitat area. These concerns may limit or interfere with drilling operations. While the proposed Cook Inlet OCS Lease Sale 244 area remains relatively ice-free during the winter, the unpredictability of winter weather conditions may limit drilling operations either by logistics or the additional expense required to conduct winter operations. After a discovery is made by an exploratory well, an operator will use MODUs to drill delineation wells to determine the areal extent of economic production. Operators need to verify that sufficient volumes of oil or gas are present to justify the expense of installing a production platform and pipelines.

Discoveries that can use existing infrastructure are generally less expensive to develop, making it possible to develop smaller fields that were previously uneconomic. The Cook Inlet area has an established infrastructure for distribution of produced oil and gas. As a result, no delays in delineation drilling are expected after an initial discovery is made. Delineation drilling would be followed by permitting activities for the OCS development project, submission of an approvable DPP by the operator, and preparation by BOEM of an EIS for, at a minimum, the first DPP proposed for the planning area. When the project is approved, the design, fabrication, and installation of each platform could take another 2 to 3 years to complete. Offshore and onshore pipeline permitting and construction would occur simultaneously with the offshore platform work. This E&D Scenario schedule assumes that the operator will commission subsequent platforms without an extended period of evaluation of the initial wells. Setting the platforms and drilling the production wells would occur over a period of 7 years.

As many as 10 wells might be associated with exploring and delineating these prospects, including unsuccessful exploration wells on other prospects in the proposed Lease Sale Area, the drilling of which could be prompted by news of the first commercial discovery. Successful exploration and delineation wells could be converted to production wells. However, to ensure that potential environmental impacts are not underestimated, this scenario assumes that exploration and delineation wells will be plugged with cement and new wells must be drilled for production. Unlike Alaska OCS areas with limited infrastructure, the gas associated with oil production can be brought to market at the same time as the oil production. In this E&D Scenario, it is assumed that a commercial oil discovery is brought to production (i.e., initial platform and export pipeline installations) first, while a commercial gas discovery is brought on line by a second round of platform and pipeline installation. Gas production is piped to the first oil development platform and then to shore via the gas-export pipeline. An additional platform and oil and gas gathering lines are then installed to support expanded oil and associated gas production from the oil field.

2.4.5. Development Activities

After an operator commits to develop a prospect, project designs will be evaluated and the operator will make development decisions based on, among other things, experience; expectations; and availability of equipment, personnel, and materiel. Another operator with a different set of experiences and expectations would make different decisions about how best to develop a prospect. The development and production plan is likely to undergo revision during the development phase as the operator incorporates lessons learned and understanding of the reservoirs gained through drilling and production. Development activities include installing production platforms and pipelines, drilling production wells, and installing tie-ins to existing shore-based infrastructure. Figure 2.4.5-1 shows the schedule of platform installation and well drilling from the E&D Scenario.

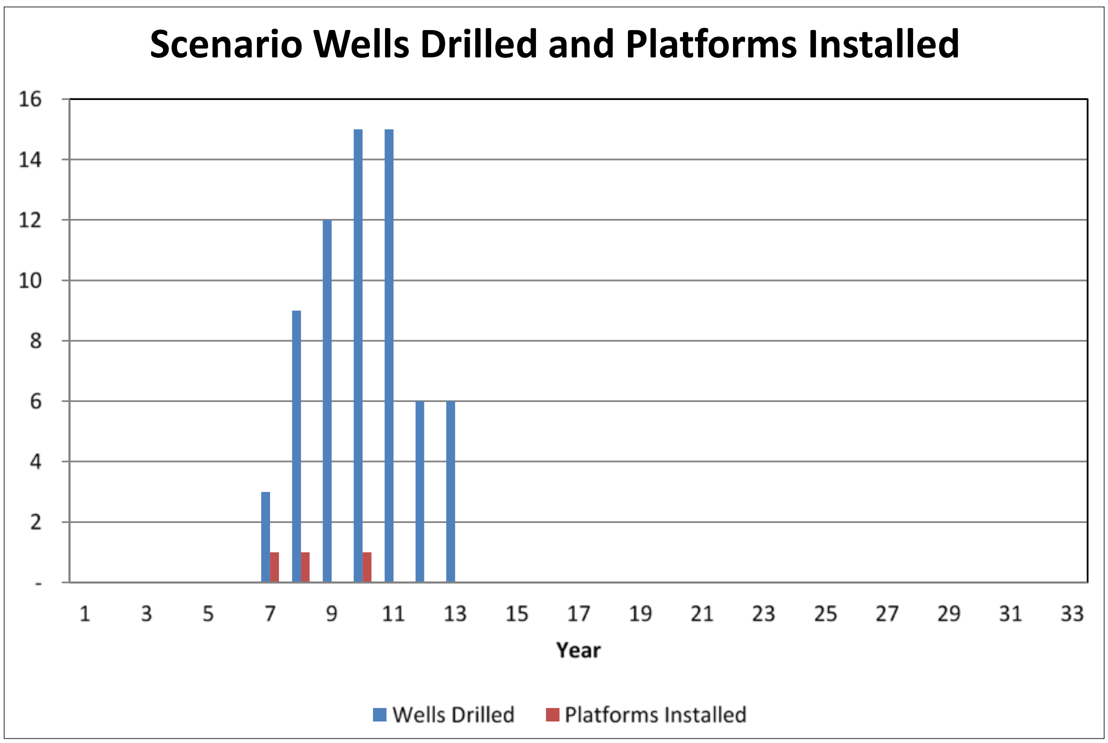

Figure 2.4.5-1. Production and Service Well Drilling and Platform Installation Schedule. *(Conducted during the E&D Scenario)*

Platforms and Development Wells

Water depth, sea conditions, and ice conditions are important factors in selecting a platform type. The existing platforms in Cook Inlet located in state waters were constructed onshore, floated to the targeted location, and installed. Due to the extreme tides and seasonal ice conditions in Cook Inlet, there are no subsea wells (wells that reach the seafloor via a seafloor template at distance from the platform) included in the E&D Scenario (i.e., all wells reach the surface at a production platform). In this scenario it is assumed that the production platform will be a steel-caisson platform constructed and designed to be tide and ice resistant. Each platform will contain up to 24 well slots. Each of the three platforms in the scenario would house production and service (injection) wells, processing equipment, fuel, and quarters for personnel. The first platform serves as a hub, connecting pipelines from other platforms to the main pipelines to shore. A maximum of six wells per year may be drilled per platform in the scenario development.

The production slurry (oil, gas, and water) will be gathered on the platforms. Gas and produced water will be separated and water re-injected into the reservoir using service wells. Gas production (from a dry-gas pool and associated with produced oil) will be piped to the hub platform and then to shore for marketing. Disposal wells will handle waste water from the crew quarters and mess facilities on the platforms. Treated well cuttings and fluid wastes for platform wells could be injected in disposal wells or barged on a routine basis along with other solid waste to an onshore treatment and disposal facility located at the shore base.

Drilling Wastes

Based on the geologic analysis, exploration and delineation wells will average approximately 1,829 m (6,000 ft) in true vertical depth. The average exploration or delineation well will produce approximately 435 tons of fluid and 747 tons of dry rock cuttings. BOEM assumes that drilling wastes (fluids and cuttings) will be disposed of at the 7 to 10 exploration and delineation well sites that are scattered throughout the Cook Inlet Program Area. If a discovery is made, development wells might average 2,286 m (7,500 ft) in measured depth. Most development wells are drilled at an angle, rather than straight down, making the drilled distance of a typical development well longer than an exploration well drilled to the same formation. The average development well will produce approximately 839 tons of dry rock cuttings. Drilling fluids from development wells will be reused or injected into disposal wells; cuttings will be either ground and injected or barged to an onshore disposal site.

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 single well and most (80%) of the drilling fluids are recycled. BOEM assumes that the discharged drilling fluids used for drilling the shallowest part of the well will be a common water-base fluid of the generic composition shown below. Fluid discharges are regulated by Federal and state agencies.

Composition of Typical Drilling Fluid (based on EPA, Type 2, Lignosulfonate Fluid)

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

Pipelines

The preferred method to transport oil and gas from the platform would be subsea pipelines to the nearest landfall location, probably on the Kenai Peninsula between Homer and Nikiski, depending upon where the first commercial oil discovery is located. Based upon the distance from pipelines already in place in upper Cook Inlet, it is not anticipated that any of the production platforms from new discoveries in the lower Cook Inlet will be able to utilize any existing pipelines.

The primary pipeline carrying produced oil from the initial platform to shore will be a 30 cm (12 in.) diameter pipeline, based upon the anticipated production rates from the discovered prospects. Where subsea soil conditions allow, the pipelines will be trenched using a subsea trenching jet similar to the method employed for the proposed Trans-Foreland pipeline to be installed between the Kustatan Production Facility on the west side of Cook Inlet to the Kenai Pipeline Company Tank Farm near Nikiski. If soils are not conducive to pipeline burial, anchors may be used to provide support and stability for the pipeline necessary to resist tidal movements. Construction of the pipelines is anticipated to occur between the beginning of May and the end of September.

After the OCS infrastructure project is constructed, operations will largely involve resupply of materiel and personnel, inspection of various systems, maintenance, and repair. Crews will be rotated at regular intervals. Maintenance and repair work will be required on the platforms and processing equipment will be upgraded to remove bottlenecks in production systems. Well repair work will be required to keep both production and service wells operational. Pipelines will be inspected and cleaned regularly by internal devices (e.g., pipeline inspection gauges or “pigs”). Crews will be rotated at regular intervals.

Transportation

The Cook Inlet basin has been producing oil and gas from State offshore leases since the mid-1960s, as a result it is expected that E&D Scenario activities generated from Cook Inlet OCS exploration and production would be compatible with existing usage. Because of this history, one key assumption made regarding this E&D Scenario is that the existing onshore infrastructure serving the proposed Lease Sale 244 area has sufficient capabilities without requiring major expansion efforts or modifications. During exploration seismic surveys, the vessels are largely self-contained. Seismic operations would be conducted in the summer/fall open-water season after commercial fishing season has ended. We assume that the smaller support vessel would make occasional trips (one to two per week) to refuel and resupply (probably operating out of Homer or Nikiski).

Operations at remote locations in the Cook Inlet Lease Sale 244 area will require transportation of supplies and personnel by different means, depending on seasonal constraints and phase of the operations. While the lower Cook Inlet remains relatively ice-free during the winter months, water conditions may prevent supply vessels from tying up safely at the platform. Under these conditions, helicopters would be used for basic resupply and crew rotation operations.

During exploration drilling, operations would be supported by both helicopters and supply vessels. Helicopters would probably fly from Nikiski or Homer at a frequency of one to three flights per day. Support-vessel marine traffic would be expected to occur at a frequency of one to two times (trips) per week, also out of Homer or Nikiski.

OCS construction (i.e., platform and pipeline installation) and development drilling operations would be supported by both helicopters and supply vessels from existing facilities located in either Homer or Nikiski. Helicopters probably would fly from either Homer or Nikiski at a frequency of one to three flights per platform per day during development operations. Support-vessel traffic is estimated to consist of one to three trips per platform per week from either Homer or Nikiski. During normal production operations, the frequency of helicopter flights offshore would remain the same (1-3 per platform per day), but marine traffic would drop to about one to two trips per week to each platform. Marine traffic would occur year round since this area remains ice free during the winter. If barges are used to transport the drill cuttings and spent fluid from production wells, during drilling operations, a dedicated barge could make one to two trips per week to an onshore disposal facility.

2.4.6. Production Activities

Oil production will commence with the drilling of the first platform production well and ramp up as more wells are drilled. In the Cook Inlet the associated gas produced with the oil can be sold to the local natural gas distribution system. Gas sales begin when the first oil production well is brought on line. Service wells will continue to re-inject produced water throughout oil and gas sales operations. Figure 2.4.6-1 shows the forecasted yearly oil and gas sales.

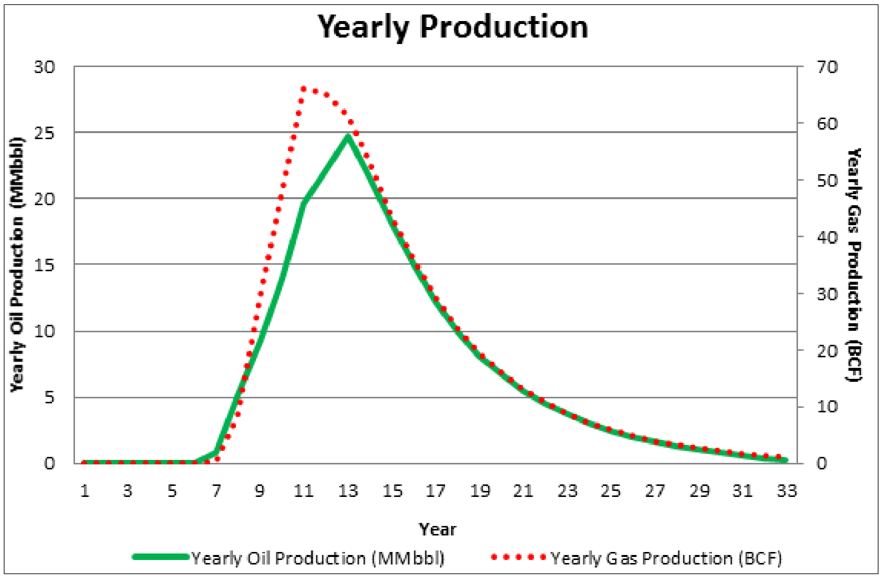

Figure 2.4.6-1. E&D Scenario Forecasted Oil and Gas Production.

Timing

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

- Each field schedule has a 3-year environmental analysis process between delineation and development on the proposed development.
- Due to the inability to predict accurately which issues may be litigated or how long the process could take, there are no delays for litigation provided in the schedule.
- It will take 4 years to install the three required production platforms. A maximum of six wells per platform may be drilled per year. The timing of well drilling determines the production schedule.

The real driver of the timeline is the time needed to install platforms and drill their associated wells after a discovery is made. Each platform is installed, commissioned, and producing in its first year. The oil and gas fields may be physically overlain, but the scenario depicted assumes no wells or facilities could be shared. If the oil and gas fields overlap, wells from the platforms could be completed in both oil and gas zones, reducing the overall number of platforms and the number of wells.

2.4.7. Decommissioning Activities

After oil and gas resources are depleted and income from production no longer pays operating expenses, the operator will begin to shut down the facilities. In a typical situation, wells will be permanently plugged with cement, wellhead equipment removed, and casings cut off to 15 feet below the mudline. Processing modules will be moved off the platforms. Subsea pipelines will be decommissioned by cleaning the pipeline, plugging both ends, and leaving them buried in the seabed. Lastly, the platform will be disassembled and removed from the area. Post decommissioning surveys would be required to confirm that no debris remains and pipelines were decommissioned properly.

2.5. Activity Levels under Alternatives 2 through 6

This section evaluates how the activities described in the E&D Scenario (Section 2.4) would differ under the other alternatives analyzed in the EIS.

2.5.1. Alternative 2 (No Action)

Under Alternative 2 (No Action), Lease Sale 244 would not occur. None of the activities described in the E&D Scenario would occur.

2.5.2. Alternatives 3A, 3B and 3C (Beluga Whale Critical Habitat Exclusion, Critical Habitat Mitigation, and Nearshore Feeding Areas Mitigation)

Alternatives 3A and 3B would exclude or require additional mitigation in 10 OCS blocks totaling 2.68% of the proposed Lease Sale Area. Due to the small area affected by these alternatives, overall activity levels are assumed to be the same as for the Proposed Action. Under Alternative 3B (Beluga Whale Critical Habitat Mitigation), lessees would not conduct on-lease seismic surveys or exploration drilling between November 1 and April 1 in the 10 blocks. It is assumed that on-lease seismic surveys and exploration drilling in the 10 blocks would be rescheduled to other times of year. However, overall activity levels are assumed to be the same as for the Proposed Action.

The E&D Scenario anticipates that 2 marine seismic surveys would be performed as a result of Lease Sale 244. Alternative 3C forbidding marine seismic surveys between November 1 and April 1 would minimally affect activity levels because an operator is unlikely to want to perform a marine seismic survey in the winter when cold temperatures, winter storms, and floating ice would make operations more difficult and more expensive. The prohibition of marine seismic surveys from July 1 through September 30 is likely to have the greatest impact on activity levels because the weather is favorable for conducting marine seismic surveys and the restriction affects 65% of the proposed Lease Sale Area. However, surveys could still be performed from April 1 through June 30, and Stipulation 4 allows an operator to request a waiver to this requirement. Thus, with a flexible schedule or prior planning, an operator would still be able to conduct marine seismic surveys. Alternative 3C may force an operator to reschedule a marine seismic survey or to request and justify a waiver to a stipulation, but it is unlikely to impact activity levels resulting from Lease Sale 244.

2.5.3. Alternatives 4A and 4B (Northern Sea Otter Critical Habitat Exclusion or Mitigation)

Alternatives 4A and 4B would affect 7 OCS blocks totaling 2.69% of the proposed Lease Sale Area. Due to the small area affected by these alternatives, overall activity levels are assumed to be the same as for the Proposed Action. Under Alternative 4B (Northern Sea Otter Critical Habitat Mitigation), lessees would be prohibited from discharging drilling fluids and cuttings or conducting seafloor disturbing activities (including anchoring and placement of bottom-founded structures) within 1,000 m of the northern sea otter critical habitat. The additional mitigation would eliminate certain activities in portions of the 7 blocks and could result in redistribution of activities to other areas in the 7 blocks or elsewhere in the proposed Lease Sale Area. However, overall activity levels are assumed to be the same as for the Proposed Action.

2.5.4. Alternative 5 (Gillnet Fishery Mitigation)

Alternative 5 (Gillnet Fishery Mitigation) would require additional mitigation in 117 OCS blocks, or 46.05% of the proposed Lease Sale Area. Although it affects a relatively large number of blocks, none of the blocks would be excluded from the proposed Lease Sale Area. The proposed mitigation measures would restrict activities. Lessees would not be allowed to conduct on-lease seismic surveys during the drift gillnetting season as designated by the ADFG (approximately mid-June to mid-August), the optimal time frame for conducting seismic activities. Lessees would be required to notify the UCIDA of any temporary or permanent structures planned during the drift gillnetting season. The additional mitigation under Alternative 5 could change the timing of on-lease seismic surveys and potentially other activities (depending on coordination between lessees and UCIDA). Overall activity levels are assumed to be similar to or slightly less than those under the Proposed Action.

2.5.5. Alternative 6 (Prohibition of Drilling Discharges)

Alternative 6 (Prohibition of Drilling Discharges) would prohibit all discharges of drilling fluid and cuttings to Cook Inlet. The main difference (relative to the Proposed Action) would be the elimination of drilling fluid and cuttings during exploration and delineation drilling. The E&D Scenario already assumes that all drilling fluid and cuttings from development wells would be either be ground and injected into disposal wells or transported to shore under any action alternative. BOEM estimates that 7-10 exploration wells will be drilled as a result of the Proposed Action. Alternative 6 would impose additional costs for drilling exploration and delineation wells due to the requirement to transport cuttings to shore for land-based disposal. The additional costs would be a small portion of the total cost to drill exploration wells, but may discourage some small operators from bidding on leases or drilling exploration and delineation wells. However, overall activity levels are assumed to be the same as for the Proposed Action.

2.6. Mitigation Measures

Federal laws and regulations that would serve to avoid or reduce impacts from potential oil and gas activities are considered part of the Proposed Action (Alternative 1) and all other action alternatives for Lease Sale 244. Examples include the OCSLA, which grants broad authority to the Secretary of the Interior to control lease operations and, where appropriate, to undertake environmental monitoring studies (30 CFR 550, *et seq.* and 30 CFR 250 and 254).

Based on the requirements in the laws and regulations, mitigation can be implemented through binding and enforceable measures known as lease stipulations, described in Section 2.6.1. The environmental effects analyses in Chapter 4 discuss the effectiveness of the proposed stipulations described in this section where appropriate for a given resource. A summary of the overall effectiveness of each proposed stipulation is provided in the following section, immediately following the text of the stipulation.

BOEM and BSEE also issue Notices to Lessees and Operators (NTLs) and Information to Lessees and Operators (ITLs), documents that provide additional information and clarification, or interpretation of a regulation, OCS standard, or regional requirement, or that provide a better understanding of the scope and meaning of a regulation by explaining BOEM's and BSEE's interpretation of a requirement. Proposed NTLs and ITLs for proposed Lease Sale 244 are described in Sections 2.6.2 and 2.6.3, respectively.

BOEM may require additional post-lease mitigation as part of the environmental review and approval of specific exploration and development and production plans. Further mitigation may also be required by NMFS or the USFWS through the ESA Section 7 consultation process. Also, any activities that would "take" marine mammals must be authorized by a LOA or an IHA under the MMPA. These authorizations may require additional mitigation measures. Mitigation requirements are typically required by other regulatory agencies for buried pipelines constructed through wetlands on the Kenai Peninsula and for crossing beneath Anadromous Fish Streams; the USACE, Alaska District, and the state of Alaska are expected to add time of year restrictions and require specific construction methods that would minimize impacts.

2.6.1. Lease Stipulations

The following proposed Lease Stipulations would be included in all leases issued under proposed Cook Inlet Lease Sale 244.

2.6.1.1. Stipulation No. 1 – Protection of Fisheries

Under this stipulation, exploration, development, and production operations must be conducted in a manner that avoids unreasonable conflicts with fishing communities and gear (including, but not limited to subsistence, sport, and commercial fishing). To avoid unreasonable fishing activity conflicts, prior to submitting an EP or a DPP, the lessee/operator must review the planned exploration or development activities with directly affected fishing organizations, subsistence communities, and port authorities. This includes plans for: on-lease surveys, MODU mobilization and location, service vessel routes, and other vessel traffic.

The EP or DPP will include a summary of fishing activities in the area of proposed operations, an assessment of effects on fishing from the proposed activity, and measures to be taken by the lessee/operator to prevent unreasonable conflicts. The assessment of effects and measures to minimize or prevent unreasonable conflicts must be described under the environmental assessment, as required by 30 CFR 550.227 for EPs and 30 CFR 550.261 for DPPs.

BOEM may restrict lease-related uses if the RSLP determines that the lessee's/operator's proposed measures will not minimize or prevent unreasonable conflicts. The RSLP will work with directly affected parties, if necessary, to ensure that potential conflicts are identified and efforts are taken to minimize or avoid these conflicts. These efforts may include timing operations to avoid fishing activities, locating structures away from major currents where fishing activities may be denser, or other restrictions including directional drilling, seasonal drilling, subsea completion techniques and other technologies deemed appropriate by the RSLP.

Summary of the Effectiveness of Stipulation No. 1. Much of the proposed Lease Sale Area has intensive commercial fishing for shellfish, groundfish, herring, and salmon during almost all periods of the year, although typically these commercial fisheries do not operate concurrently. Some seasons, such as that for herring, are very short. The fishing areas also are widespread, ranging from shoreline to far offshore. While widely distributed, some areas have high concentrations of fishing vessels and gear.

In addition, subsistence fishing occurs throughout Cook Inlet. Most of the households in the communities of Port Graham and Nanwalek participate in subsistence harvests. These communities, along with the community in Tyonek, have substantial subsistence harvests that include salmon, halibut, crab, and clams.

Sport fishing also occurs throughout the proposed Lease Sale Area and in adjacent waters. People fish for salmon, halibut, lingcod, and rockfish from chartered and private vessels or from the shore, and harvest shellfish such as clams and crabs.

Without safeguards, subsistence, sport, and commercial fishing may be subject to interference from OCS oil and gas operations. This issue was raised during scoping for Lease Sale 244. The conflict addressed in this stipulation primarily is spatial; therefore, the purpose of this stipulation is to ensure that the petroleum industry and the participants engaged in subsistence, sport, and commercial fishing have a mechanism to coordinate activities and minimize conflicts. The stipulation, developed in part, as a way of addressing specific characteristics of the various commercial activities that occur in Cook Inlet, is expected to be effective in addressing potential conflicts.

Application of this stipulation would be expected to help ensure early planning by the petroleum industry to prevent or reduce potential conflicts with subsistence, sport, and commercial fishing. This stipulation would provide additional protection by advising lessees/operators that exploration or development and production activities should be conducted in a manner that minimizes potential conflicts between the oil and gas industry and fishing activities. This measure would be especially useful in preventing interference with these fishing interests by seismic surveys that could cause damage or loss of fixed fishing gear. This stipulation would not change the level of impacts that may occur due to an unlikely large oil spill.

2.6.1.2. Stipulation No. 2 – Protection of Biological Resources

With application of Stipulation No. 2, if biological populations or habitats that may require additional protection are identified by BOEM in the leased area, the RSLP may require the lessee/operator to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RSLP must provide written notification to the lessee/operator of the requirement to conduct such surveys.

Based on any surveys that the RSLP may require of the lessee/operator or based on other information available to the RSLP regarding special biological resources, the RSLP may require the lessee/operator to:

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

If populations or habitats of biological significance are discovered during the conduct of any operations on the lease, the lessee/operator must immediately report such findings to the RSLP and make every reasonable effort to preserve and protect the biological resource from damage. The RSLP will direct the lessee/operator with respect to the protection of the resource. The lessee/operator must submit all data obtained in the course of biological surveys to the RSLP to include geospatial information in relation to the lessee's/operator's proposed action. The lessee/operator may take no action that might affect the biological populations or habitats surveyed until the RSLP provides written directions to the lessee/operator with regard to permissible actions.

Summary of the Effectiveness of Stipulation No. 2. The level of protection provided by this measure will depend on several factors:

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

The effectiveness of this stipulation could vary widely. If only a few members of a large population, or only a small amount of a large habitat area were to be affected by oil and gas operations, the mitigation provided by the stipulation would be minimal. However, if effects are reduced or minimized to many individuals of a small population, or to most of an area of unique habitat because of this stipulation, then its effectiveness could be substantial. This stipulation would subsequently lower the likelihood of potential adverse effects to unique biological communities that may be identified during oil and gas exploration or development activities, and thus provide additional protection. It also would provide protection to fish (including migratory species) from potential disturbance associated with oil and gas exploration or development and production activities. To the extent that this stipulation may protect previously unknown biological resources that are used in subsistence harvest, the stipulation would enhance environmental justice. This stipulation would not change the level of significance for impacts that may occur due to an unlikely large oil spill.

2.6.1.3. Stipulation No. 3 – Orientation Program

With application of Stipulation No. 3, the lessee must include in any EPs or DPPs submitted under 30 CFR 550.211 or 550.241 a proposed orientation program for all personnel involved in the proposed action (including personnel of the lessee's/operator's agents, contractors, and subcontractors) for review and approval by the RSLP.

The program must be designed in sufficient detail to inform individuals working on the project of specific types of environmental, safety, social, and cultural concerns that relate to the area that could be affected by the operation or its employees. The program must address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid or minimize disturbance. The program must address safety issues and goals including, but not limited to: Stop Work Authority; Ultimate Work Authority; Employee Participation Program (Safety); and Reporting Unsafe Working Conditions. The program must be designed to increase the sensitivity and understanding of personnel to community values, customs, and way-of-life in areas where such personnel will be operating. The orientation program also must include information concerning avoidance of conflicts with subsistence, sport, and commercial fishing activities.

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

The lessee/operator must maintain, for a minimum of five years, a record of the name(s) and date(s) of attendance of all employees that have attended the orientation program.

Summary of the Effectiveness of Stipulation No. 3. This stipulation is expected to be effective in mitigating effects by requiring all personnel involved in oil and gas exploration or development and production activities in Cook Inlet resulting from any leases issued from the lease sale to attend a program that will provide awareness of the unique environmental, social, and cultural values of local residents, including Alaska Native residents. This stipulation should help avoid damage to or destruction of environmental, cultural, and archaeological resources by increasing awareness and understanding of historical and cultural values. It also should help minimize potential conflicts between subsistence use activities and oil and gas activities. However, the degree to which potential conflicts will be minimized by this stipulation is difficult to measure.

The stipulation would provide protection from potential disturbances associated with oil and gas exploration or development and production activities to fish (including migratory fish), marine birds and shorebirds, pinnipeds, beluga whales, and other species, by increasing worker understanding of the surrounding environment. The orientation program would increase the sensitivity and understanding of workers to the values, customs, and way-of-life of Alaska Native communities, and reduce potential conflicts with subsistence activities. The stipulation would enhance environmental justice by reducing potential effects to people involved in subsistence uses. This stipulation would not change or lower the level of significance for impacts that may occur from an unlikely large oil spill.

2.6.1.4. Stipulation No. 4 – Transportation of Hydrocarbons

With Stipulation No. 4, pipelines would be required for transporting produced hydrocarbons to shore if BOEM determines that: (a) pipeline rights-of-way can be determined and obtained; (b) laying such pipelines is technologically feasible and use of pipelines is environmentally preferable to other means, and (c) pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts.

BOEM may require that any pipeline used for transporting produced hydrocarbons to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to recommendations of knowledgeable advisory groups and Federal, state, and local governments, and industry.

Summary of the Effectiveness of Stipulation No. 4. This stipulation reflects the agency's considerations for transporting produced hydrocarbons in a safe, environmentally sound, and practicable way. This stipulation would help reduce risks to water quality, lower trophic level organisms, fish and fish migration, endangered species, marine mammals, and other resources from spills resulting from oil and gas transportation. In doing so, the stipulation would enhance environmental justice through the agency's determination of whether or not a pipeline is the preferred method of transportation.

2.6.2. Notices to Lessees and Operators

NTLs provide additional information and clarification, interpret a regulation, OCS standard, or regional requirement, or provide a better understanding of the scope and meaning of a regulation by explaining BOEM's interpretation of a requirement. There are three active NTLs specific to the BOEM or BSEE Alaska OCS Region (USDOI, BOEM, 2015c):

- NTL 2005-A01 – Shallow Hazards Survey and Evaluation for Exploration and Development Drilling
- NTL 2005-A02 – Shallow Hazards Survey and Evaluation for Alaska Outer Continental Shelf (OCS) Pipeline Routes and Rights-of-Way
- NTL 2005-A03 – Archaeological Survey and Evaluation for Exploration and Development Activities

2.6.2.1. NTL 2005-A01 – Shallow Hazards Survey and Evaluation for Exploration and Development Drilling

Unless the lessee/operator can demonstrate that sufficient data are available to evaluate a site for potential hazards, a geophysical shallow hazards survey is required prior to exploration or development drilling or platform construction. NTL 2005-A01 provides guidance to lessees/operators conducting shallow hazards surveys. The RSLP requires pre-exploratory and pre-development investigations by lessees/operators on leased lands to ensure safe conduct of oil and gas operations on the OCS. Before beginning drilling or platform construction activities, lessees/operators must conduct a shallow hazards analysis to evaluate the proposed site for potentially hazardous conditions at or below the seafloor that could affect the safety of operations.

NTL 2005-A01 provides detailed requirements regarding survey design, survey grids, seafloor imagery, bathymetry, water column anomaly detection, high-resolution seismic profiling systems, magnetometers, navigation, shallow core data, and reporting.

2.6.2.2. NTL 2005-A02 – Shallow Hazards Survey and Evaluation for Alaska Outer Continental Shelf (OCS) Pipeline Routes and Rights-of-Way

NTL 2005-A02 provides guidance to lessees/operators conducting shallow hazards surveys for pipeline routes and rights-of-way. BOEM requires investigation of all areas considered for pipeline routes, and documentation of any existing natural hazardous conditions to be provided before BOEM approval of any development plan(s). A high-resolution geophysical survey and geotechnical analysis are required, and development plans must consider any existing natural hazardous conditions within their design and avoidance criteria, to minimize potential impacts to the environment.

NTL 2005-A02 includes detailed guidance for conducting shallow hazards surveys for pipeline routes, and includes requirements regarding survey design, subbottom profiling, seafloor imagery, bathymetry, water column anomaly detection, magnetometers, geotechnical investigations, navigation, and reporting. No seafloor disturbing activities, with the exception of geotechnical investigations, are authorized without approval of the RSLP.

2.6.2.3. NTL 2005-A03 – Archaeological Survey and Evaluation for Exploration and Development Activities

Before a lessee/operator is allowed to commence drilling, facility construction, or pipeline rights-of-way activities, BOEM may require archaeological surveys and analysis to evaluate the location and condition of any submerged archaeological resources that could be affected by the proposed activities. An archaeological resource report analyzes geophysical survey data for indications of archaeological resources. When notified by the Regional Director (RD) that archaeological resources may exist in the lease area, the lessee/operator must perform an archaeological survey and an archaeological report must be included in the exploration or development plan or pipeline right-of-way application. When BOEM determines that the survey data and analysis indicate the potential for an archaeological site(s) to be affected, the lessee/operator must either:

- employ operational procedures to ensure the protection of the site
- adjust the location of the site to a distance necessary to avoid disturbance to, or avoid, the potential site
- perform additional investigations to establish to the satisfaction of the RSLP that archaeological resources do not exist at the site or would not be adversely affected by the proposed activities

NTL 2005-A03 provides guidance to lessees and operators conducting archaeological surveys before E&D activities. NTL 2005-A03 provides detailed guidance about the conduct of archaeological surveys, including requirements regarding survey design, seafloor imagery, bathymetry, acoustic subbottom profilers, magnetometers, navigation, shallow core data, and reporting.

2.6.3. Information-to-Lessees and Operators

The following proposed Information-to-Lessees and Operators would be included in all leases issued under proposed Cook Inlet Lease Sale 244:

- ITL No. 1 – Bird and Mammal Protection
- ITL No. 2 – Endangered and Threatened Species
- ITL No. 3 – Potential Effects of Seismic Surveys: Environmental and Regulatory Review and Coordination Requirements
- ITL No. 4 – Archaeological and Geological Hazards Reports and Surveys
- ITL No. 5 – Sensitive Areas to be Considered in Oil Spill Response Plans
- ITL No. 6 – Discharge Prohibition in Certain Areas
- ITL No. 7 – Trash and Debris Awareness and Elimination

2.6.3.1. ITL No. 1 – Bird and Marine Mammal Protection

With this ITL, lessees are advised that during all activities related to leases issued as a result of this lease sale, the lessee and its agents, contractors, and subcontractors will be subject to the provisions of the following laws, among others: the MMPA of 1972, as amended (16 U.S.C. 1361 *et seq.*); the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 *et seq.*); the Migratory Bird Treaty Act (MBTA), as amended (16 U.S.C. 703-712 *et seq.*), and the Bald and Golden Eagle Protection Act (BGEPA), as amended (16 U.S.C. 668-668c). Violations of these acts, as well as applicable international treaties, will be reported to NMFS or the USFWS, as appropriate. The ESA requirements are discussed in ITL No. 2 (Endangered and Threatened Species).

Lessees and their contractors should be aware that under the MMPA, disturbance of marine mammals could be determined to constitute a "take." The MMPA defines "take" as "harass, hunt, capture, collect, or kill or attempt to harass, hunt, capture, or kill any marine mammal." Applicants can receive authorization to incidentally, but not intentionally, take marine mammals under the MMPA through two processes: a LOA or an IHA. The difference between the two types of incidental take authorizations is explained on the NMFS website. The process may require 12 to 18 months for an LOA and 6 to 9 months for an IHA.

Requests for incidental take authorizations under the MMPA should be directed to the appropriate agency. Of the marine mammal species that may occur in or adjacent to Cook Inlet, NMFS is responsible for managing whales, dolphins, seals, and sea lions, and the USFWS is responsible for managing sea otters. Procedural regulations governing take under the MMPA are at 50 CFR Part 216 for the NMFS and 50 CFR Part 18 for the USFWS. Instructions for obtaining an incidental take authorization are available on the NMFS and USFWS websites.

Of particular concern is disturbance at major wildlife concentration areas, including bird colonies, marine mammal haulout and breeding areas, and wildlife refuges and parks. Maps depicting major wildlife-concentration areas in Cook Inlet are available from the RSLP. Lessees also are encouraged to confer with NMFS and USFWS in planning transportation routes between shore bases and lease holdings.

Generally, behavioral disturbance of most birds and mammals would be unlikely if aircraft and vessels maintain a > 1-mile horizontal distance and aircraft maintain at least a 457-m (1,500-ft) altitude when in transit near known or observed wildlife concentration areas, such as seabird colonies, and marine mammal haulout and breeding areas. Viewing guidelines and other protective measures for marine mammals are provided on the NMFS Alaska Regional Office's website (https://alaskafisheries.noaa.gov/protectedresources/mmv/guide.htm).

Lessees are advised that the MBTA makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. The bird species protected by the MBTA are listed in 50 CFR 10.13.

Lessees are advised that the BGEPA prohibits anyone from taking, possessing, or transporting a Bald Eagle (*Haliaeetus leucocephalus*) or Golden Eagle (*Aquila chrysaetos*), or the parts, nests, or eggs of such birds without prior authorization. This includes active or inactive nests. The BGEPA defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb." "Disturb" means "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. Activities that directly or indirectly lead to take are prohibited without a permit.

2.6.3.2. ITL No. 2 – Endangered and Threatened Species

Lessees are advised the ESA of 1973, as amended (16 U.S.C. 1531 *et seq.*), protects endangered or threatened species that may be in or adjacent to the area of the Proposed Action as listed in Table 2.6.3-1. Of the marine mammal species that may occur in or adjacent to Cook Inlet waters, NMFS manages whales and sea lions and the USFWS manages northern sea otters. The USFWS also manages the threatened bird species.

Table 2.6.3-1. Threatened and Endangered Species in or Near the Proposed Lease Sale Area.

Common Name	Scientific Name	ESA Status	Critical Habitat	
			Proposed Lease Sale Area	Cook Inlet Region
Marine Mammals				
Beluga whale (Cook Inlet DPS)	*Delphinapterus leucas*	Endangered	Yes	Yes
Fin whale	*Balaenoptera physalus*	Endangered	No	No
Humpback whale	*Megaptera novaeangliae*	Endangered	No	No
North Pacific right whale	*Eubalaena japonica*	Endangered	No	Yes
Sei whale	*Balaenoptera borealis*	Endangered	No	No
Sperm whale	*Physeter microcephalus*	Endangered	No	No
Blue whale	*Balaenoptera musculus*	Endangered	No	No
Northern sea otter (Southwest Alaska DPS)	*Enhydra lutris kenyoni*	Threatened	Yes	Yes
Steller sea lion (Western DPS)	*Eumetopias jubatus*	Endangered	No	Yes
Birds				
Short-tailed albatross	*Phoebastria albatrus*	Endangered	No	No
Steller's Eider (Alaska breeding population)	*Polysticta stelleri*	Threatened	No	No

Note: DPS = distinct population segment; ESA = Endangered Species Act.

Lessees are advised that BOEM will perform an environmental review for each proposed EP and DPP, including an assessment of direct, indirect, and cumulative effects on endangered and threatened species. Should the review conclude that activities described in the plan will be a threat of serious, irreparable, or immediate harm to the species, the RSLP will require that activities be modified, or otherwise mitigated, before such activities are approved.

Lessees are further advised that in the event information obtained from BOEM or lessee monitoring programs indicates activities conducted on a lease pose a threat of serious, irreparable, or immediate harm or damage to the marine environment, including threatened and endangered species, the BSEE RS/FO can consider or direct a suspension of operations for that lease until such time as the issue can be resolved. This suspension is made is accordance with 30 CFR 250.172 and can be terminated when the issue has been resolved.

The NMFS and USFWS will review EPs and DPPs submitted to BOEM to ensure that threatened and endangered species are protected. Lessees should contact the NMFS and USFWS regarding proposed operations and actions that might be taken to minimize interaction with these species.

2.6.3.3. ITL No. 3 – Potential Effects of Seismic Surveys: Environmental and Regulatory Review and Coordination Requirements

With this ITL, lessees are advised of the potential effect of seismic surveys on beluga whales, northern sea otters, other marine mammals, coastal birds, and subsistence hunting and fishing activities, and commercial fishing activities. Lessees are advised that all seismic survey activity conducted in the Cook Inlet Planning Area, as an ancillary activity in support of an EP or DPP (30 CFR 550), is subject to review by BOEM to ensure ancillary activity complies with the performance standards listed in 30 CFR 550.202.

BOEM may impose restrictions on seismic surveys including the timing of operations and other requirements such as having a locally approved coordinator on board to minimize unreasonable conflicts between seismic survey activities and subsistence activities and/or commercial fishing activities.

Lessees and applicants are advised that BOEM may require any proposed seismic activities to be coordinated with the appropriate agencies, co-management organizations, and directly affected subsistence communities to identify potential conflicts and develop plans to avoid these conflicts.

2.6.3.4. ITL No. 4 – Archaeological and Geological Hazards Reports and Surveys

Regulations at 30 CFR 550.214(e) and 30 CFR 550.244(e) require a shallow hazards report to be included with all EPs or DPPs at the time they are submitted to BOEM. In addition, the RD may require lessees to include an archaeological resources report as required by 30 CFR 550.227(b)(6) and 30 CFR 550.261(b)(6) with any EP or DPP submitted to BOEM.

Potential submerged archaeological resources range from historic to prehistoric. Historic resources include man-made objects or structures older than 50 years, such as shipwrecks, abandoned relics of historic importance, or submerged airplanes. The likelihood of historic resources is determined by historical records, and tentative locations of historic resources are identified in the Alaska Shipwreck Database. There may be other occurrences of historic resources and these will be determined during survey work.

Guidance and detailed survey requirements are provided in NTL 2005-A03 for archaeological surveys; NTL 2005-A01 for shallow hazards surveys prior to E&D drilling on a lease; and NTL 2005-A02 for shallow hazards surveys of pipeline routes and rights-of-way. These NTLs are available online on the BOEM website.

2.6.3.5. ITL No. 5 – Sensitive Areas to be Considered in Oil Spill Response Plans

Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fish, other biological resources or cultural resources, and for their importance to subsistence harvest activities. Lessees are advised to consider these areas when developing OSRPs. Identified areas and time periods of special biological and cultural sensitivity for Cook Inlet include the following:

- Critical habitat for the Cook Inlet DPS of beluga whale (50 CFR 226.220)
- Critical habitat for the Southwest Alaska DPS of northern sea otter (50 CFR 17.95 (a))
- Critical habitat for the Western DPS of Steller sea lion (50 CFR 226.202)
- Critical habitat for the North Pacific right whale (50 CFR 226.215)
- National Park System units including Lake Clark NPP, Katmai NPP, Kenai Fjords National Park, and Aniakchak National Monument and Preserve
- NWRs including Alaska Maritime, Alaska Peninsula, Becharof, Kenai, and Kodiak
- Kachemak Bay National Estuarine Research Reserve (NERR)
- Alaska State Park units including Afognak Island State Park; Kachemak Bay State Park and State Wilderness Park; Shuyak Island State Park; and the Captain Cook, Clam Gulch, and Ninilchik State Recreation Areas
- State critical habitat areas including Clam Gulch, Fox River Flats, Kachemak Bay, Kalgin Island, Redoubt Bay, and Tugidak Island

- Wildlife and game sanctuaries, refuges, and preserves including Anchorage Coastal Wildlife Refuge; McNeil River State Game Sanctuary and Refuge; and the Goose Bay, Susitna Flats, Palmer Hay Flats, and Trading Bay State Game Refuges
- Other areas of concentrated biological resources including Chisik and Duck Islands, Kamishak Bay, Kachemak Bay, the Barren Islands, Marmot Island, Tugidak Island, Chirikof Island, Puale Bay, and the Pye Islands
- A national historic landmark (Yukon Island Main Site, near Homer) which has been identified as sensitive
- Port Graham/Nanwalek AMSA as identified in the Kenai Borough Coastal Management Plan

These areas are among areas of special economic or environmental importance to be considered in the OSRP (30 CFR 254.26). Lessees are advised that they have primary responsibility for identifying these areas in their OSRPs and for providing specific protective measures. Additional areas of special economic or environmental importance may be identified during review of EPs and DPPs.

Lessees are advised to consult with the USFWS, the NPS, or state or borough personnel to identify specific environmentally-sensitive areas within NWRs, NPS units, or state special areas that should be considered when developing a project-specific OSRP.

2.6.3.6. ITL No. 6 – Discharge Prohibition in Certain Areas

Lessees are advised that the NPDES general permit AKG-28-5100 issued by the EPA prohibits all discharges from OCS oil and gas exploration facilities in Kamishak Bay west of a line from Cape Douglas to Chinitna Point (EPA, 2015a). The discharge prohibition applies to all or part of the following OCS blocks within OPD NO05-01: 6436, 6484, 6485, 6486, 6532, 6533, 6534, 6535, 6536, 6582, 6583, 6584, 6585, 6632, 6633, 6634, and 6635. In addition, the NPDES general permit prohibits discharges within 4,000 m (13,123 ft) of the Port Graham/Nanwalek AMSA near the Lower Kenai Peninsula. The discharge prohibition applies to a portion of OPD NO05-02, Block 6612.

Lessees are also advised that the NPDES general permit (GP) AKG-31-5000 issued by the EPA authorized the discharge of drilling fluids and cuttings from exploration facilities and prohibited discharges of drilling fluids and drill cuttings from oil and gas development and production facilities classified as new sources, as defined in Appendix A of the permit (EPA, 2007). GP AKG-31-5000 expired in July 2012 and was administratively extended by EPA until a new GP authorizing the discharge of drilling fluids and drill cuttings from exploratory facilities and other discharges becomes effective. On July 29, 2015 the EPA signed GP AKG-28-5100 authorizing the NPDES discharges for oil and gas exploration facilities in Federal waters of Cook Inlet. GP AKG-28-5100 will become effective on September 1, 2016. In addition to authorizing the discharge of drilling fluids and drill cuttings from exploratory facilities, GP AKG-28-5100 also authorizes discharges of deck drainage, sanitary wastes, domestic wastes, desalination unit wastes, blow preventer fluid, boiler blowdown, fire control system test water, non-contact cooling water, uncontaminated ballast water, bilge water, excess cement slurry, as well as fluid, cuttings, and cement at seafloor.

While GP AKG-31-5000 prohibited operational discharges to certain areas near Kamishak Bay and the Port Graham/Nanwalek AMSA, discharges from operations in Cook Inlet are prohibited by GP AKG-28-5100 in the following areas:

1. Ten Meter Isobath. Facilities are prohibited from discharging shoreward of the 10 meter mean lower low water isobath.
2. Geographic Restrictions. Facilities are prohibited from discharging in the following areas:
    a. Within 20 nautical miles of Sugarloaf Island as measured from a centerpoint at latitude 58°53' N, longitude 152°02' W.

b. In Kamishak Bay, west of a line from Cape Douglas to Chinitna Point
c. In Shelikof Strait, south of a line between Cape Douglas on the west (latitude 58°51' N, 153°15' W) and the northernmost tip of Shuyak Island on the east (latitude 58°37' N, 152°22' W).
d. Within the Port Graham/Nanwalek Area Meriting Special Attention (AMSA) and the 4000 m buffer surrounding the AMSA.

The NPDES general permits for the Cook Inlet OCS oil and gas exploration facilities are available online on the EPA website. Lessees are advised to contact EPA Region 10 for further information.

2.6.3.7. ITL No. 7 –Trash and Debris Awareness and Elimination

Trash and debris pose a threat to marine mammals, birds, fish, and other wildlife; cause costly delays and repairs for commercial and recreational boating interests; detract from the aesthetic quality of recreational shore fronts; and increase maintenance costs for parks and refuges.

Because oil and gas operations can contribute to this chronic problem, BSEE regulations at 30 CFR 250.300(a) and (b)(6) prohibit lessees from deliberately discharging containers and other similar materials (i.e., trash and debris) into the marine environment. Other regulations (30 CFR 250.300(c) and (d)) require lessees to make durable identification markings on equipment, tools and containers (especially drums), and other material, and to record and report items lost overboard to the BSEE RS/FO through facility daily operations reports.

Furthermore, the intentional jettisoning of trash has been the subject of strict laws such as MARPOL Annex V and the Marine Plastic Pollution Research and Control Act, and regulations imposed by various agencies including the USCG and the EPA. These USCG and EPA regulations further require that lessees become more proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins.

Lessees are expected to exercise special caution when handling and disposing of small items and packaging materials, particularly those made of non-biodegradable, environmentally persistent materials such as plastic or glass that can be lost in the marine environment and washed ashore. Increasing worker awareness of the problem and emphasizing their responsibilities will help reduce the litter problem further and control the unintended loss of items such as empty buckets, hard hats, shrink wrap, strip lumber, and pipe thread protectors.

2.6.4. Mitigation Carried Forward from the 2012-2017 OCS Leasing Program

Beginning with the 2012-2017 OCS Oil and Gas Leasing Program, BOEM established a tracking table to increase the visibility of recommendations for alternatives, exclusions, and mitigations at different stages of the leasing process (USDOI, BOEM, 2015b). The table tracks the lineage and treatment of suggestions for spatial exclusions and/or mitigation originating at the programmatic stage to the lease sale phase, and on to the plan review and approval phase. This table allows those who made comments to see how, and at what stage of the process, their concerns are being considered. Each of these measures were considered and partially analyzed in the 2012-2017 OCS Oil and Gas Leasing Program, with the direction that these measures “will be analyzed further and considered in greater detail at subsequent stages,” specifically including the lease sale stage. Table 2.6.4-1 lists alternatives, exclusion, and other mitigation recommendations identified in the 2012-2017 OCS Oil and Gas Leasing Program and summarizes their disposition in the Lease Sale 244 EIS.

Table 2.6.4-1. Disposition of 2012-2017 Five Year Program Mitigation Recommendations.*

Tracking Number	Suggestion or Recommendation	Disposition during Area ID Process	Resolution in Lease Sale 244 EIS
Cook Inlet Planning Area			
AK.CI.d.1	Exclude northern portion of proposed Lease Sale Area because of uncertain risks to beluga whale population.	Identified as a measure to be considered for inclusion in Lease Sale EIS.	An alternative that would exclude the northern half of the proposed Lease Sale Area was considered, but will not be analyzed in detail because it would not meet the Purpose and Need. The objective is largely addressed by Alternative 3A and Alternative 3B.
AK.CI.d.2	Exclude blocks that may adversely affect natural and cultural resource values of NPS units within area.	The Area ID reduced potential effects to parks, preserves, and refuges by narrowing the geographic extent of the program area and reduced proximity to Katmai NPP. Residual effects to be considered in Lease Sale EIS.	The EIS evaluates potential impacts to NPS units. The only NPS unit near the proposed Lease Sale Area is Lake Clark NPP. BOEM considered an exclusion but did not incorporate into the EIS because: (1) OCS blocks included in the proposed Lease Sale Area are already at least 3 miles from Lake Clark NPP; (2) routine OCS activities are not expected to have significant impacts on Lake Clark NPP; (3) no shore bases or other onshore facilities would be located in or near the NPP; and (4) a buffer zone would not necessarily prevent impacts from a large accidental spill.
AK.CI.d.3	Exclude Beluga Whale Critical Habitat.	The Area ID excluded most of the beluga whale critical habitat within or adjacent to Cook Inlet Planning Area. Residual area to be considered in Lease Sale EIS.	Recommendation incorporated into Alternative 3A.
AK.CI.d.4	Exclude Northern Sea Otter Critical Habitat.	The Area ID excluded most of the northern sea otter critical habitat within or adjacent to Cook Inlet Planning Area. Residual area to be considered in Lease Sale EIS.	Recommendation incorporated into Alternative 4A.
AK.CI.m.1	Set minimum required contribution per tract leaseholder to Cook Inlet Regional Citizens Advisory Council (CIRCAC) to use for Oil Pollution Act of 1990 mandated programs.	BOEM has no legal authority to require such payments by lessees. Not considered further.	Not considered in the EIS.
AK.CI.m.2	Ensure that future lease sale submissions possess a sufficient measure of oil spill response capabilities.	Identified as a factor to be considered for inclusion in Lease Sale EIS.	Federal regulations require lessees/operators to document in their EPs and DPPs that they possess a sufficient measure of oil spill response capabilities. Review of the adequacy of oil spill response capabilities occurs during BOEM and BSEE review of individual EPs and DPPs.
Alaska-Wide			
AK.1	Consider ecologically and culturally important areas.	Identified as a factor to be considered for inclusion in Lease Sale EIS.	The EIS evaluates potential impacts on ecologically and culturally important areas.
AK.2	Consider important subsistence and biological areas.	Identified as a factor to be considered for inclusion in Lease Sale EIS.	The EIS evaluates potential impacts on important subsistence uses and biologically important areas.
AK.3	Create buffers around sensitive areas and resources.	The Area ID reduced potential effects to sensitive areas and resources by narrowing the geographic extent of the program area. Residual effects to be considered in Lease Sale EIS.	The EIS evaluates impacts on sensitive areas and resources. Alternatives for beluga whale critical habitat (3A, 3B and 3C) and northern sea otter critical habitat (4A and 4B) include buffers in that mitigation or exclusion applies to entire blocks overlapping with critical habitat; Alternative 5 includes mitigation to reduce impacts to drift gillnetting.

Tracking Number	Suggestion or Recommendation	Disposition during Area ID Process	Resolution in Lease Sale 244 EIS
AK.4	Protect areas upstream and downstream of important ecological areas.	Identified as a factor to be considered for inclusion in Lease Sale EIS.	The EIS evaluates impacts on important ecological areas including areas upstream and downstream from the proposed Lease Sale Area. Under lease Stipulation No. 2, if BOEM identifies biological populations or habitats that may require additional protection in the leased area, the RSLP may require the lessee/operator to conduct biological surveys to determine the extent and composition of such biological populations or habitats.
AK.5	Consider measures that will protect bowhead whales and subsistence communities.	Identified as a measure to be considered for inclusion in Lease Sale EIS.	Bowhead whales are not expected to occur in the proposed Lease Sale Area. The EIS evaluates impacts on subsistence harvests and includes mitigation measures to reduce them.
AK.6	Seasonal restrictions in subsistence areas.	Identified as a measure to be considered for inclusion in Lease Sale EIS.	The EIS evaluates impacts on subsistence uses and includes mitigation measures to reduce them.
AK.7	Restrictions during migratory, breeding, and birthing periods.	Identified as a measure to be considered for inclusion in Lease Sale EIS.	Timing restrictions were incorporated into Alternative 3B (Beluga Whale Critical Habitat Mitigation). Alternative 3C restricts seismic and exploration activity around anadromous fish spawning areas during spawning season. No other timing restrictions relevant to migratory, breeding, or birthing periods were identified.
AK.8	Delay leasing until adequate spill control and response available.	Identified as an alternative to be considered for inclusion in Lease Sale EIS.	Delaying the lease sale was considered as an Alternative in Section 2.3.1, but not analyzed in detail. It is considered equivalent to Alternative 2 (No Action).

Note: *Disposition of Recommendations for Alternatives, Exclusions, and Mitigation Measures from the 2012-2017 OCS Oil and Gas Leasing Program Mitigation Tracking Table (USDOI, BOEM, 2015b).

2.7. Issues for Impact Analysis

2.7.1. Issues Analyzed

All comments received in response to the RFI and NOI to prepare an EIS, and those received during public scoping meetings, are part of the record of information used in developing the EIS, and will be available to decision-makers during the deliberation process. BOEM reviewed and evaluated all information collected during the scoping process to identify resources, impact-producing factors, and issues for detailed analysis in this EIS. Key issues identified during the scoping process include, but are not limited to, the following:

- Impacts of oil spills to all living organisms and their habitats from accidental small or large spills, taking into account the challenges associated with conducting oil spill response, recovery, cleanup, and environmental monitoring in Cook Inlet
- Potential impacts of oil spills, including oil spill drills and oil spill response activities, discharges, underwater noise, vessel traffic, and other factors on marine mammal critical habitat. The critical habitat for the beluga whale and northern sea otter are located in or adjacent to the proposed Lease Sale Area, and critical habitat for the Steller sea lion and North Pacific right whale exists in the region.
- Disturbance of animal migrations and behavior by seismic surveys and by drilling and production activities
- Potential impacts on commercial and sport fishing, including the Cook Inlet gillnet fishery, beach fishing, halibut long-liners, salmon charter fishing, and the nascent mariculture industry.

Particular concerns include oil spills, discharges, the presence of surface structures, and vessel traffic

- Potential impacts on subsistence fishing and traditional use areas. Particular concerns include oil spills, discharges, the presence of surface structures, and vessel traffic.
- Potential contamination of fishery nursery areas, and aquatic food chains, due to oil spills
- Potential impacts on areas of special concern including state and national parks, state game refuges and sanctuaries, state critical habitat areas, and other protected and/or sensitive areas. Areas frequently mentioned in scoping comments include Kachemak Bay, Kamishak Bay, Tuxedni Bay, Augustine Island, the Port Graham/Nanwalek AMSAs, NWRs, and NPS units.
- Potential impacts on eco-tourism due to visual impacts and introduction of additional oil and gas development in a pristine area
- Potential impacts on water quality due to drilling discharges
- Potential impacts on existing vessel traffic, including tankers
- Potential constraints and risks due to natural hazards including tides, tsunamis, rip currents, storms, volcanoes, and landslides. Particular concerns include the possibility that natural hazards could increase the risk of a large oil spill or limit the effectiveness of spill response activities.
- Direct, indirect, and cumulative impacts on climate change and ocean acidification

Table 2.7.1-1. Impact-Producing Factors and Potentially Affected Resources.

Impact-Producing Factors	Potentially Affected Resources
• Seafloor disturbance and habitat alteration • Drilling discharges • Other operational discharges • Water intake • Underwater noise • Air pollutant emissions • Physical presence including lights • Trash and debris • Vessel traffic • Aircraft traffic and noise • Fluid and Cuttings transport and disposal • Onshore support activities • Employment and project spending • Accidental oil spills and gas release	• Air quality • Water quality • Acoustic environment • Lower trophic level organisms • Fish and shellfish • Marine mammals • Terrestrial mammals • Birds • Coastal and estuarine habitats • Economy and population • Commercial fishing • Subsistence-harvest patterns • Sociocultural systems • Public and community health • Recreation and tourism, and visual resources • Sport fishing • Archaeological and historic resources • Areas of special concern • Oil and gas and related infrastructure

BOEM used a systematic approach to ensure that all relevant issues were evaluated in this EIS. The process is explained in Section 4.1. Briefly, based on the E&D Scenario and assumptions presented in Section 2.4, BOEM identified categories of impact-producing factors (IPFs) (i.e., impact agents) flowing from the Proposed Action, and categories of potentially affected resources, as listed in Table 2.7.1-1. Each of the resources is described in Chapter 3. In Chapter 4, a matrix approach is used to identify all potential interactions between IPFs and resources, and to determine which interactions need to be evaluated in greatest detail.

2.7.2. Issues Considered but not Analyzed

Several issues raised during scoping were not considered for detailed study in the EIS, because they were out of its scope or inherently did not affect the environmental analyses. These issues included administrative, policy, or process issues. For example, the following issues identified in the Scoping Report (USDOI, BOEM, 2015a) were not analyzed in the EIS:

- Perceived inconsistencies and inadequacies in jurisdictional authority, regulations, and enforcement between state and Federal agencies and among Federal agencies with regard to oil and gas activities in Cook Inlet
- Dissatisfaction with the NEPA process for previous Cook Inlet lease sales
- Recommendations for better coordination and data sharing among regulatory agencies
- Recommendations to incorporate by reference all comments submitted on previous oil and gas lease sales
- Impacts associated with end use consumption of oil and gas resources which may be produced as a result of this lease sale

It is acknowledged that some portion of the oil and gas produced from Lease Sale 244 leases would be consumed as fuel; however, because end use consumption is not part of the Proposed Action, and because any attempt to quantify a marginal increase in national oil and gas consumption (much less resulting environmental effects) attributable to Lease Sale 244 oil and gas would be unduly speculative, this EIS does not attempt to quantitatively analyze or model environmental effects from the end use consumption of produced oil and gas.

2.8. Summary of Impacts by Alternative

This section briefly summarizes the environmental impacts that could occur under the alternatives outlined in Section 2.2. The summaries are presented by alternative for each resource area potentially affected under that alternative, and are based on the detailed analysis provided in Chapter 4. The impact analysis assumes that the activities included in the E&D Scenario (Section 2.4) would occur under each of the action alternatives.

The terms “negligible,” “minor,” “moderate,” and “major” used below are derived from the Impacts Scale defined in Section 4.1.1 of this document, where the terms are defined 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

The impact analysis includes both routine activities and accidents. Routine activities are all of the planned activities that are included in the E&D Scenario (Section 2.4). An accident is an unplanned event or sequence of events that results in an undesirable consequence. In this analysis, the undesirable consequence is an oil spill or gas release in the environment. The analysis distinguishes between small spills and a large but reasonably foreseeable spill or gas release:

- **Small spills** – accidental oil spills that are < 1,000 bbl. BOEM considers two oil types for small spills: crude and refined oil. BOEM estimates a total of 460 (rounded to nearest ten) small crude or refined oil spills over the life of the E&D Scenario (Appendix A).
- **Large spill** – an accidental oil spill that is > 1,000 bbl. BOEM estimates the chance of no large spill occurring is 78%, and the chance of one or more large spills occurring is 22% over the life of the E&D Scenario (Appendix A). Although unlikely, each “large spill” impact determination is based on the assumption that a large spill occurs.
- **Gas release** – BOEM also assumes that up to one well control incident of a single well could occur, releasing 8 MMcf of natural gas in one day (Appendix A). A gas release was included in

the analysis, but a separate impact scale determination was not made for a gas release because the impacts are estimated to be no greater than those for a large spill for any resource.

The analysis separately considers potential impacts from a Very Large Oil Spill (VLOS), which is considered a low probability, high impacts event.

In summary, the impact analysis for each resource includes both routine activities and accidents and resulted in separate impact scale determinations for routine activities, small spills, and a large spill. A further determination of potential impacts is made for a hypothetical VLOS event.

2.8.1. Impacts of Alternative 1 (Proposed Action)

Air Quality

Due to Clean Air Act permit requirements for stationary sources and the use of emissions control technology or equipment to ensure adherence to air quality standards, measurable impacts from stationary sources at the nearest air quality monitoring stations from routine activities are expected to be **minor**.

The impact of accidental small oil and gas spills is likely to be **minor** due to the limited geographical and temporal extent of impacts in the area as confined as the Cook Inlet. Impacts due to a large spill on air quality also are likely to be **minor.**

Water Quality

Most impacts from routine operations would be short-term or transient, localized to the project infrastructure or along support vehicle/aircraft routes, and affect relatively small offshore areas since all infrastructure and activities associated with the Proposed Action will occur >4.8 km (3 mi) from the coastline. Adherence to NPDES permitting requirements would protect against any undue degradation of the marine environment. Overall, the effects from routine activities would be short-term, localized, and **minor**.

Overall, impacts to water quality from accidental small spills are deemed **minor** due to the localized and short-term nature of the impacts. A large spill may result in **moderate** impacts, based on the potential for widespread and long-lasting impacts.

Acoustic Environment

Due to the temporary nature and localized footprint of the additional acoustic sources in the Proposed Action, impacts to the acoustic environments are expected to be **minor** for routine activities. Impacts to the acoustic environment from small spills are expected to be **negligible** due to most spills evaporating and dissipating within 24 hours without any required response. Impacts from a large spill would be **minor** due to the generally short duration of peak response effort.

Lower Trophic Level Organisms

The overall impact of routine operations of the Proposed Action on lower trophic level organisms would be temporary and localized and is expected to be **minor**. Overall, impacts from accidental spills to lower trophic level organisms would not be sustained at a population level, and are expected to be **minor** for small spills. Large spills that reach coastal areas could have more persistent impacts to benthic invertebrates and could require remediation. Impacts are expected to be **moderate** for a large spill.

Fish and Shellfish

The effects of routine exploration, development, and production activities would impact individual fish and shellfish locally, but not at a widespread population level. Consequently, the overall effects of routine exploration, development, and production activities on fish and shellfish would be **minor**.

The effects of small spills would likely be localized and temporary, resulting in **minor** effects to individual fish and shellfish. Although a small oil spill could cause minor effects to fish and shellfish, it is unlikely to have a measureable effect on local populations. A large spill impacting subtidal and intertidal habitats would have a **moderate** impact on fish and shellfish, resulting in lethal and sublethal effects on forage fish and intertidal species. Local populations of nearshore fish and shellfish would be measurably depressed for about a year, and small amounts of oil could persist in shoreline sediments for a decade or more. However, the spill would affect a small portion of the total habitat and likely would be limited to subpopulation-level effects.

Marine Mammals

Most IPFs from routine activities in the Proposed Action are expected to have **negligible to minor** levels of effects on marine mammals, primarily resulting from anthropogenic noise and vessel traffic that would occur as a result of the Proposed Action. Substantive protections mandated by the MMPA and, in the case of some species, the ESA, would further ensure the impacts from routine activities do not exceed statutory and regulatory standards. Additional restrictions would be imposed on a project-specific basis (e.g. through incidental take authorizations issued by NMFS and USFWS) to ensure that impacts do not exceed established thresholds. Small spills are expected to have a **negligible** level of effect on marine mammals due to their limited size, ease of management and cleanup, weathering, and volatilization of spill constituents. A large spill is estimated to have a **moderate** impact on sea otters alone, and a **negligible** level of effects to other marine mammals due to spill size assumptions, biology and ecology of each marine mammal species, existing mitigation, and the lack of effects from historical spills much larger than what was assumed to be most likely large spill associated with the Proposed Action.

Terrestrial Mammals

Most impacts to terrestrial mammals from routine activities would be localized to the site of the project infrastructure offshore in the proposed Lease Sale Area, geographically distant from terrestrial habitats. Onshore activities would primarily occur in already developed areas and would not result in substantial impacts on terrestrial mammals. Overall, routine activities are expected to result in **negligible** impacts on terrestrial mammals.

Because small spills are expected to evaporate or disperse prior to contacting terrestrial habitats, impacts to terrestrial mammals are expected to be **negligible**. Overall, impacts on terrestrial mammals from a large spill are expected to be **minor** due to the low potential for adverse impacts from oiling of individuals or habitats. While some terrestrial mammals could become oiled, no effects that could be measured at the population or subpopulation level are anticipated.

Birds

Impacts of the Proposed Action on birds are rated as **minor** to **moderate** for routine activities (primarily due to the potential for long-lasting and widespread, but less than severe, impacts to a few species that have been identified as having declining, small, or otherwise limited populations vulnerable to various stressors such as chronic collision risk). Impacts to the ESA-listed population of Steller’s eider as a result of routine activities are expected to be negligible to minor, because only tens of individuals of the listed population are believed to be among the species’ wintering population (i.e., primarily non-listed), and therefore at risk of impacts, in the Action Area. The magnitude and extent of impacts on birds from accidental spills will be a function of a variety of factors, including (1) the time of year of the spill, (2) the volume of the spill, (3) the type of product spilled, (4) environmental conditions at the time of the spill, (5) the habitats exposed to the spill, (6) the species exposed to the spill or that utilize the impacted habitats, (7) the effectiveness of response activities, and (8) the results of response activities. Overall, impacts to birds from small spills are expected to be **minor** and impacts to birds from large spills are expected to be **moderate to major**.

Coastal and Estuarine Habitats

The expected direct impacts to vegetation and wetland resources as a result of routine activities in the E&D Scenario are **minor** because they would be localized. These impacts would not have a severe effect on the ecological functions, species abundance, or composition of wetlands and plant communities of Cook Inlet.

Impacts from small spills would be **minor** because they would be short-term and only impact a geographically limited area. It is expected that most small spills would evaporate before reaching coastal and estuarine habitats. The impacts of a large spill to coastal and estuarine habitats could be **major**, depending on the location.

Economy and Population

Overall, the effects of routine activities from the Proposed Action on the economy and population would be short-term and localized, and thus **minor**. Exploration, development, and production activities would generate additional employment, earnings, and revenues for local, state, and Federal governments. However, the increase in employment, earnings, revenues, and population would be proportionally small compared to the current economy and population.

Adverse effects of a potential spill would be limited in scope and insufficient to offset the overall beneficial effects of the Proposed Action. The effects of small spills therefore would be **negligible**. Although a large oil spill could have some identifiable effects on the economy, it is unlikely to measurably affect the economy or local population. Consequently, the overall effects of a large spill on the economy and population are expected to be short-term and localized, and thus **minor**.

Commercial Fishing

The physical presence of production platforms near riptide locations could have a localized but long-term impact on the drift gillnet fishing industry. However, as a whole, it is likely that commercial fishers would be able to use alternative fishing grounds during times of space-use conflict. Consequently, the overall effects of routine activities on commercial fishing are anticipated to be **minor**.

Small spills that may occur under the Proposed Action are likely to have a short-term and localized effect on commercial fishing before dilution and weathering reduced concentrations of oil in the water. Consequently, it is anticipated that small spills would have **minor** effects on commercial fisheries in Cook Inlet. Large spills that may occur under the Proposed Action would likely have long lasting and widespread effects on pelagic fishes that are important for commercial harvest and sale, especially if important habitat areas were to become contaminated from a large oil spill. Therefore, as a consequence of reduced catch, loss of gear, and/or loss of fishing opportunities for an entire season or more and during cleanup and recovery periods, the overall effects of a large spill could result in **moderate** impacts to commercial fishing in Cook Inlet.

Subsistence Harvest Patterns

Short-term access to subsistence resources and localized hunting areas could be affected by reductions and changes in the distribution of important subsistence resources such as fish and shellfish and other marine invertebrates and marine mammals. Overall, the effects of routine activities on subsistence harvest patterns are expected to be **minor** because these would most likely be short-term and/or localized and less than severe.

Impacts from small spills would be localized, short-term, less than severe, and thus are expected to be **minor** for subsistence harvests patterns. Impacts from a large spill of crude oil could cause severe and thus **major** effects to subsistence harvest patterns due to their potential to 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.

Sociocultural Systems

Effects to sociocultural systems from routine activities associated with the Proposed Action are expected to be short-term and localized, and thus **minor**. Social systems are expected to successfully respond and adapt to the change brought about by the continuation of exploration and production activities.

Impacts to sociocultural systems from small spills are expected to be **minor** due to their limited geographic and temporal effects. Impacts from a large spill of crude oil could be **major**, depending on the spill location relative to the resources impacted and the duration and extent to which impacts from a large spill disrupt subsistence activities and social organization. Impacts from a large spill would have an indirect and severely adverse effect on sociocultural systems if subsistence fishing and hunting, commercial fishing, and/or personal use salmon fishing were disrupted for one or more seasons.

Public and Community Health

Overall impacts to public and community health from routine operations under the Proposed Action are expected to be short-term and localized, and thus **minor**. Impacts from small spills are expected to be **minor** because they also will be short-term and localized. In the case of a large oil spill, impacts to public and community health could be long lasting and widespread, and thus **moderate**, depending on the size and location of a spill and whether or not impacts disrupt subsistence harvest activities for one or more seasons, alter local health care provision, disrupt traditional sharing networks, and/or threaten cultural values and identities.

Recreation and Tourism, and Visual Resources

The effects of the Proposed Action on recreation and tourism would primarily arise from space use conflicts. However, these activities usually take place in different locations or at different times; when they coincide, the duration would be short-term and localized. Overall, the effects of routine activities on recreation, tourism, and visual resources are expected to be **minor**.

Small spills would result in little or no impact and thus have **negligible** effects on recreation and tourism. Small spills are expected to have **minor** impacts on visual resources due to their short-term and localized effects. A large oil spill could cause long lasting and widespread effects to coastal-dependent and coastal-enhanced recreational and tourism values, especially where oil makes contact with the shoreline. The effects would last the duration of the spill response and cleanup activities. Overall, potential effects of a large spill on recreation, tourism, and visual resources are expected to be **moderate**.

Sport Fishing

The effects of routine activities on sport fishing would be geographically limited and short-term. Activities that would occur under exploration, development, production, and decommissioning could temporarily limit access to some regular sport fishing areas and may displace some populations of sport species such as salmon and halibut in the short term. It is likely that charters and individual sport fishers would be able to use alternative fishing grounds; therefore, charters would not likely lose a large portion of business as a result of routine operations. The overall effects of routine activities during the Proposed Action on the sport fishing community and industry would be **minor**.

The effects of small spills would be considered **minor** because they are anticipated to be contained with the on-site spill response resources, which will minimize the geographic extent of any impact. A large oil spill could cause long lasting and widespread effects to the sport fishing community and industry. Such a spill could limit the ability of sport halibut and salmon fishers from setting out from oiled locations; it could also affect clam gathering. In any area contacted by oil, populations of the intertidal organisms could be depressed measurably for about a year, and small amounts of oil likely would persist in the shoreline sediments for more than a decade. The overall effects of a large spill would result in **moderate** impacts on sport fishing resources.

Archaeological and Historic Resources

While archaeological and historic resources are nonrenewable resources and any routine activity could have a potential long-term negative impact, the likelihood of direct impacts to archaeological and historic resources is expected to be low due to required geohazard surveys prior to seafloor-disturbing activities and archaeological surveys of proposed routes of terrestrial pipelines. As a result of the earlier analysis, the impacts of routine operations in Cook Inlet from the Proposed Action on archaeological and historic resources are expected to be **negligible**.

In the case of accidental spills, some impacts on shoreline archaeological and historic sites, historic shipwrecks, and submerged prehistoric archaeological resources may occur. While following proper procedures and cleanup protocols would mitigate most impacts, some impacts may still result in the loss of information from oil spill cleanup or vandalism of historic properties. As a result, the impacts of accidental spills from the Proposed Action on archaeological and historic resources would be **minor** for small spills and **moderate** for large spills, based on the severity of the spill and the proximity of archaeological resources.

Areas of Special Concern

Overall, impacts from routine activities as a result of the Proposed Action would result in **minor** impacts to Areas of Special Concern due to potential short-term effects from discharges, greenhouse gas emissions, and aircraft traffic and noise. A small oil spill would result in **negligible** impacts to Areas of Special Concern due to the distance from shore and small area of contamination. In the unlikely event of a large oil spill, impacts to water quality and coastal habitats and natural resources of the Cook Inlet region are expected to be **major**.

Oil and Gas and Related Infrastructure

Overall, the effects of routine activities from the Proposed Action on oil and gas and related infrastructure would be **negligible**. Impacts from small spills on oil and gas and related infrastructure would be **negligible**. Large spills could result in **minor** impacts to oil and gas and related infrastructure, primarily due to temporary area closures as a result of spill cleanup operations that could impact supply vessels rigs, or other infrastructure in Cook Inlet.

Environmental Justice

Executive Order 12898 (59 *FR* 7629; February 16, 1994) requires each Federal agency to make environmental justice part of its mission by identifying and addressing disproportionately high and adverse (i.e., major) human health or environmental effects of its programs, policies, and activities on minority populations, low-income populations, and Indian tribes (CEQ, 1997).

The evaluation of environmental justice impacts of proposed Lease Sale 244 on environmental justice communities in the proposed Lease Sale Area focuses on the Alaska Native, subsistence-based communities of the affected areas. Potential high and adverse effects from large oil spills would most likely produce disproportionately high and adverse effects to environmental justice communities because of their reliance on subsistence foods for nutritional, social, and cultural well-being and because effects of large oil spills to subsistence harvest patterns and sociocultural systems are expected to be major. Oil-spill contamination of subsistence foods and related adverse effects to community well-being from distress and disruptions to social patterns and community cohesiveness would likely be the primary impacts on human health for environmental justice communities. Impacts of large spills to public and community health are expected to be moderate for the Kenai Peninsula Borough as a whole but could be disproportionately high and adverse for environmental justice communities due to their distinct cultural practices and subsistence ways of life. The likelihood of a large spill occurring and affecting subsistence resources and harvest areas is relatively small; nevertheless, in the event that a large oil spill occurred and contaminated essential subsistence resources and harvest areas, high and adverse effects could occur when impacts from contamination of the shoreline, tainting concerns, spill response and cleanup disturbance, and disruption of subsistence practices are factored together. Impacts from a large spill are anticipated to be greater in extent and magnitude for environmental justice communities than for predominantly non-Alaska Native communities. A large spill is expected to have disproportionately high and adverse effects on Alaskan Native peoples living in environmental justice communities.

2.8.2. Impacts of Alternative 2 (No Action)

Under the No Action Alternative (Alternative 2), the Secretary would decline to hold the Cook Inlet Lease Sale 244. Selection of this alternative would eliminate the possibility for OCS oil and gas development and production as a result of Lease Sale 244, although such activities could occur within the Cook Inlet 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 State of Alaska (corporate income taxes), and the Federal Government (lease rentals, taxes, royalties on production) would not be realized from Lease Sale 244. In addition, a variety of adverse and beneficial impacts generally associated with petroleum production could be displaced to other localities, both domestic and foreign.

2.8.3. Impacts of Alternative 3A, 3B and 3C

Alternative 3A – Beluga Whale Critical Habitat Exclusion

Under Alternative 3A, the beluga whale critical habitat blocks would be excluded from Lease Sale 244. Excluding the blocks would not change the overall level of activity under the E&D Scenario and therefore would not change the risk or severity of impacts from small or large accidental spills. Alternative 3A would reduce the risk of impacts on beluga whales relative to Alternative 1 (Proposed Action). By implementing Alternative 3A, the overall impact ratings for beluga whales would be reduced to a **negligible** level of effects, and the effects on other marine mammals mostly remain unchanged: **minor** for routine activities, **negligible** for small spills, and **moderate** for a large spill without any mitigations. With the mitigations NMFS typically imposes, such as PSOs, onboard vessels, avoidance protocols, ramp up, ramp down, shutdown, start up, and 1,500 ft minimum altitudes for aircraft associated with the Proposed Action, and the presence of oil spill response protocols and infrastructure, the level of effects from large spills would be reduced to **negligible** for all marine mammals other than sea otters, while the level of effects from small spills would be **negligible**. The level of effects to sea otters from a large spill would most likely be **minor** to **moderate**, depending on specific spill characteristics and trajectories. Likewise, applying the standard suite of NMFS and USFWS mitigations to routine activities would reduce the level of effects from routine activities to **negligible** for all marine mammals.

Alternative 3B – Beluga Whale Critical Habitat Mitigation

Under Alternative 3B, the 10 beluga whale critical habitat blocks would be included in Lease Sale 244, but with timing restrictions when beluga whales are most likely to be present. The timing restrictions would not change the risk or severity of impacts from small or large accidental spills nor would they substantially change the risk or severity of impacts on beluga whales in the remainder of the proposed Lease Sale Area. Alternative 3B would reduce the risk of impacts on beluga whales relative to Alternative 1 (Proposed Action). Alternative 3B would be less effective than

Alternative 3A in reducing impacts because the scheduling restriction for on-lease seismic surveys, exploration activities, and development and production activities would not be eliminated. The overall impact ratings for marine mammals remain unchanged: **minor** for routine activities, **negligible** for small spills, and **moderate** for a large spill without any mitigations. With the standard suite of NMFS and USFWS mitigations there should be a **negligible to minor** level of effects to marine mammals from routine activities, **negligible** from small spills, and a **negligible** level of effects from large spills for all marine mammals other than sea otters. Sea otters would experience a **moderate** level of effects from a large spill due to the severe adverse effects oiling often has on the insulative integrity of their fur.

Alternative 3C – Beluga Whale Critical Habitat Nearshore Feeding Areas Mitigation

Under Alternative 3C, 224 OCS blocks would be offered for lease with seasonal mitigation to protect beluga whales. No on-lease marine seismic surveys would be conducted between November 1 and April 1, when beluga whales are most likely to be present and distributed across Lower Cook Inlet. For the 146 OCS blocks located wholly or partially within 10 miles of major anadromous streams, no on-lease marine seismic surveys would take place between July 1 and September 30 when beluga whales are migrating to and from their summer feeding areas. Alternative 3C would be more effective than Alternative 3A or Alternative 3B in reducing noise impacts on marine mammals and fish because of the greater scheduling restrictions on seismic surveys, and the protection of larger watershed estuarine areas used by marine mammals, including Cook Inlet beluga whales, as feeding areas. The mitigations outlined in this alternative would protect most marine mammals in the vicinity of the proposed Lease Sale Area to a greater degree than other alternatives and greatly lower the likelihood of Level A or Level B Harassment from occurring to marine mammals, especially during summer when they feed near river mouths. The mitigations in Alternative 3C would not protect marine mammals from the effects of oil spills.

Alternative 3C would slightly reduce the risk of impacts on beluga whales and fish relative to Alternative 1 (Proposed Action). The overall impact ratings for marine mammals would remain unchanged: **minor** for routine activities, **negligible** for a small spill, and **moderate** for a large spill for sea otters/**negligible effects** to other marine mammals without any mitigations. With the standard suite of NMFS and USFWS mitigations there should be a **negligible to minor** level of effects to marine mammals from routine activities, **negligible** level of effects from small spills, and a **negligible** level of effects from large spills for all marine mammals other than sea otters. Sea otters would experience a **moderate** level of effects from a large spill due to the severe adverse effects oiling often has on the insulative integrity of their fur. The overall impacts on fish and shellfish would remain unchanged: **minor** for routine activities, **minor** for small spills, and **moderate** for large spills.

2.8.4. Impacts of Alternatives 4A and 4B

Alternative 4A - Northern Sea Otter Critical Habitat Exclusion

Under Alternative 4A, the sea otter critical habitat blocks would be excluded from Lease Sale 244. Alternative 4A would reduce the potential for interactions between sea otters and OCS oil and gas activities in those blocks; however, excluding the blocks would not change the overall level of activity under the E&D Scenario and therefore would not change the risk or severity of impacts from small or large accidental spills. Additionally, the exclusion of the sea otter critical habitat blocks would not substantially change the risk or severity of impacts on sea otters in the remainder of the proposed Lease Sale Area. Alternative 4A would reduce the risk of impacts on sea otters relative to Alternative 1 (Proposed Action).

However, though the overall impact ratings for marine mammals would remain unchanged: **minor** for routine activities, **negligible** for small spills, and **moderate** for a large spill, the level of effects on sea otters would be **negligible** for routine activities and small spills, and **moderate** for large spills. Mitigation measures required by the USFWS in LOAs would mitigate the effects of activities on sea otters. The suite of mitigations the USFWS typically imposes (e.g., PSOs on vessels, ramp up, ramp down, start up, shut down, minimum altitude for project aircraft, marine mammal avoidance protocols, and the existence of oil spill protocols and infrastructure) would reduce the level of effects from small spills and routine operations to **negligible** effects, while the effects of large oil spills would be **moderate** for sea otters, depending on spill characteristics, and trajectories. For all other marine mammals the NMFS and USFWS mitigations would reduce the level of effects from a large spill from moderate to **negligible**.

Alternative 4B - Northern Sea Otter Critical Habitat Mitigation

Under Alternative 4B, the sea otter critical habitat would be included in Lease Sale 244, but drilling discharges and seafloor disturbing activities would be prohibited within 1,000 m (1,094 yards) of areas designated as northern sea otter critical habitat. The prohibition of drilling discharges and seafloor-disturbing activities within the critical habitat would reduce the potential impacts on sea otters from alteration of their benthic habitats; however, other impacts would remain unchanged. For example, the mitigation in this alternative would not change the risk or severity of impacts from small or large accidental spills, nor would it substantially change the risk or severity of impacts on sea otters in the remainder of the proposed Lease Sale Area.

Alternative 4B would reduce the risk of impacts on sea otters relative to Alternative 1 (Proposed Action). The mitigation in Alternative 4B focuses on reducing benthic habitat impacts near drilling and production sites in water depths <20 m (66 ft). Alternative 4B would be less effective than Alternative 4A in reducing impacts to sea otters because the animals could still be disturbed by nearby activities including vessel and helicopter traffic and noise. However, the overall impact ratings for marine mammals remain unchanged: **minor** for routine activities, **negligible** for small spills, and **moderate** for a large spill without any mitigations. With the standard suite of NMFS and USFWS mitigations there should be a **negligible to minor** level of effects to marine mammals from routine activities, **negligible** from small spills, and a **negligible** level of effects from large spills for all marine mammals other than sea otters. Sea otters would experience a **moderate** level of effects from a large spill due to the severe adverse effects oiling often has on the insulative integrity of their fur.

2.8.5. Impacts of Alternative 5 (Gillnet Fishery Mitigation)

Alternative 5 focuses on reducing impacts to drift gillnetting; therefore, commercial fisheries are the only resource for which impacts are expected to differ substantially from those of the Proposed Action. The mitigation measures described in this alternative could reduce the total level of activity under the E&D Scenario. However, overall activity levels are assumed to be similar to or slightly less than for the Proposed Action. Alternative 5 would reduce the potential for space-use conflicts with drift gillnet fishers by scheduling seismic surveys outside of the drift gillnetting season and requiring notification of UCIDA for temporary and permanent structures during the drift gillnetting season. The impacts of routine activities on commercial fishing would be the same as for the Proposed Action: **minor**. Also, this alternative would not change the impacts of small or large accidental spills relative to the Proposed Action: **minor** for small spills and **moderate** for a large spill.

2.8.6. Impacts of Alternative 6 (Prohibition of Drilling Discharges)

Alternative 6 prohibits the discharge of drilling fluids and cuttings and requires that they be transported to shore for land-based disposal. Alternative 6 is not expected to change the total level of activity under the E&D Scenario and would not influence the estimated size, frequency, or impacts of small or large accidental spills. For most resources, the impacts of Alternative 6 would be essentially the same as those from the Proposed Action, though slight to notable differences were noted in some resources. Slight increases in air pollutant emissions and disturbances to marine mammals were noted as a result of barging cuttings to shore for disposal although the overall impact ratings for air quality and marine mammals remained the same as for the Proposed Action. In addition, the overall impact ratings for water quality did not differ from the Proposed Action despite the elimination of drilling fluid and cuttings discharges. The prohibitions in Alternative 6 did however, serve to reduce the level of impact to lower trophic level organisms and fish and shellfish resources from minor to **negligible** for routine activities.

2.8.7. Comparison of Alternatives

Table 2.8.7-1 compares the alternatives with respect to environmental impacts. The table shows important differences among action alternatives with respect to Alternative 1 (Proposed Action). Blank cells (—) indicate impacts are essentially the same as for Alternative 1.

Table 2.8.7-1. Comparison of Impacts by Action Alternative.

Resource	Impacts of Alternative 1 (Proposed Action)	Important Differences Relative to Alternative 1 (Proposed Action)[1]						
		Alternative 3A Beluga Whale CH Exclusion	Alternative 3B Beluga Whale CH Mitigation	Alternative 3C Beluga Whale CH and Near Shore Feeding Areas Mitigation	Alternative 4A Northern Sea Otter CH Exclusion	Alternative 4B Northern Sea Otter CH Mitigation	Alternative 5 Gillnet Fishery Mitigation	Alternative 6 Prohibition of Drilling Discharges
Air quality	Increased air pollutant concentrations due to emissions from engines and generators on MODUs, platforms, vessels, and helicopters. VOCs from oil spills Routine activities: **Minor** Small spills: **Minor** Large spill: **Minor**	—	—	—	—	—	—	Slight increase in air pollutant emissions due to cuttings transport to shore
Water quality	Turbidity due to seafloor disturbance and drilling discharges; water quality impacts from operational discharges; elevated hydrocarbon concentrations in water and sediments from oil spills Routine activities: **Minor** Small spills: **Minor** Large spill: **Moderate**	—	—	—	—	—	—	Eliminates all impacts of drilling fluid and cuttings discharges
Acoustic environment	Underwater noise from seismic surveys, drilling and construction activities, and support vessels Routine activities: **Minor** Small spills: **Negligible** Large spill: **Minor**	—	—	Eliminates or reduces noise ≥160 dB in 146 OCS blocks within 10 miles of major anadromous streams	—	—	—	—
Lower trophic level organisms	Burial of benthic organisms due to seafloor disturbance at MODU and platform sites; burial and smothering of benthic organisms near exploration wellsites; plankton entrainment and impingement by cooling water intakes Routine activities: **Minor** Small spills: **Minor** Large spill: **Moderate**	—	—	—	—	—	—	Eliminates all impacts of drilling fluid and cuttings discharges

Resource	Impacts of Alternative 1 (Proposed Action)	Important Differences Relative to Alternative 1 (Proposed Action)[1]						
		Alternative 3A Beluga Whale CH Exclusion	Alternative 3B Beluga Whale CH Mitigation	Alternative 3C Beluga Whale CH and Near Shore Feeding Areas Mitigation	Alternative 4A Northern Sea Otter CH Exclusion	Alternative 4B Northern Sea Otter CH Mitigation	Alternative 5 Gillnet Fishery Mitigation	Alternative 6 Prohibition of Drilling Discharges
Fish & shellfish	Demersal fish habitat altered by seafloor disturbance at MODU and platform sites and drilling discharges at exploration wellsites; entrainment and impingement of fish eggs and larvae by cooling water intakes Routine activities: **Minor** Small spills: **Minor** Large spill: **Moderate**	—	—	Eliminates or reduces impacts of noise ≥160 dB on anadromous fish populations in 146 OCS blocks within 10 miles of major anadromous streams	—	—	—	Eliminates all impacts of drilling fluid and cuttings discharges
Marine mammals	Disturbance by underwater noise from seismic surveys, drilling activities, and vessel and helicopter traffic; risk of vessel strikes; lethal and sublethal effects of spills Routine activities: **Negligible to Minor** Small spills: **Negligible** Large spill: **Negligible to Moderate**	Avoids most impacts on beluga whales and their CH in 10 OCS blocks	Reduces impacts on beluga whales and their CH in 10 OCS blocks	Eliminates or reduces noise ≥160 dB in 146 OCS blocks within 10 miles of major anadromous streams	Avoids most impacts on sea otters and their CH in 7 OCS blocks	Reduces impacts on sea otters and their CH in 7 OCS blocks	—	Slight increase in disturbance by vessel traffic due to cuttings transport
Terrestrial mammals	Disturbance by onshore support activities and helicopters; impacts of spills on foraging habitat and prey species Routine activities: **Negligible** Small spills: **Negligible** Large spill: **Minor**	—	—	—	—	—	—	—
Birds	Attraction to OCS structures and lights, including risk of bird strikes; lethal and sublethal effects of spills including contamination of Important Bird Areas and bird habitats Routine activities: **Minor to Moderate** Small spills: **Minor** Large spill: **Moderate** to **Major**	—	—	—	—	—	—	—
Coastal and estuarine habitats	Few impacts from routine activities due to distance from shore; potential for extensive impacts to intertidal habitats including wetlands from spills Routine activities: **Minor** Small spills: **Minor** Large spill: **Major**	—	—	—	—	—	—	—

Resource	Impacts of Alternative 1 (Proposed Action)	Important Differences Relative to Alternative 1 (Proposed Action)[1]						
		Alternative 3A Beluga Whale CH Exclusion	Alternative 3B Beluga Whale CH Mitigation	Alternative 3C Beluga Whale CH and Near Shore Feeding Areas Mitigation	Alternative 4A Northern Sea Otter CH Exclusion	Alternative 4B Northern Sea Otter CH Mitigation	Alternative 5 Gillnet Fishery Mitigation	Alternative 6 Prohibition of Drilling Discharges
Economy and population	Minor beneficial impact due to direct and indirect employment, taxes, and royalties; no overall impact of small spills; large spills could cause economic impacts through resource damage and disruption of fishing, marine transportation, and port operations Routine activities: **Minor** Small spills: **Negligible** Large spill: **Minor**	—	—	—	—	—	—	—
Commercial fishing	Exclusion zones around MODUs and platforms; potential interactions with drift gillnetting including gear loss or damage; effects of discharges and spills on fishery species; disruption of fishing by spill response and cleanup activities Routine activities: **Minor** Small spills: **Minor** Large spill: **Moderate**	May slightly reduce potential interactions with drift gillnet fishers due to exclusion of 10 blocks at north edge of proposed Lease Sale Area	—	—	—	—	Reduces risk of interactions with drift gillnet fishers through scheduling, notification, and coordination	—
Subsistence harvest patterns	Potential interactions with subsistence harvesters; effects of spills on subsistence resources; disruption of harvesting by spill response and cleanup activities Routine activities: **Minor** Small spills: **Minor** Large spill: **Major**	—	—	—	—	—	—	Eliminates minor impacts from drilling discharges to subsistence harvest patterns
Sociocultural systems	Short-term and limited impact from routine activities; effects of spills on subsistence resources and cultural sites; possible disruption of subsistence activities by spill response and cleanup activities Routine activities: **Minor** Small spills: **Minor** Large spill: **Major**	—	—	—	—	—	—	—

Resource	Impacts of Alternative 1 (Proposed Action)	Important Differences Relative to Alternative 1 (Proposed Action)[1]						
		Alternative 3A Beluga Whale CH Exclusion	Alternative 3B Beluga Whale CH Mitigation	Alternative 3C Beluga Whale CH and Near Shore Feeding Areas Mitigation	Alternative 4A Northern Sea Otter CH Exclusion	Alternative 4B Northern Sea Otter CH Mitigation	Alternative 5 Gillnet Fishery Mitigation	Alternative 6 Prohibition of Drilling Discharges
Public & community health	Short-term and localized or negligible impact on public health from air pollutant emissions and routine discharges; spills could expose public to oil and VOCs and disrupt subsistence activities; influx of spill response workers could increase demands on local health systems Routine activities: **Minor** Small spills: **Minor** Large spill: **Moderate**	—	—	—	—	—	—	—
Recreation and tourism, and visual resources	Short-term and localized interactions with marine boating and recreational users; little to negligible impact of small spills on recreation and tourism; short-term and localized visual and aesthetic impacts from OCS structures and lights and small spills; long-term contamination and widespread but temporary closures of recreational areas due to large spills Routine activities: **Minor** Small spills: **Negligible** for recreation and tourism; **Minor** for visual impacts Large spill: **Moderate**	—	—	—	—	—	—	—
Sport fishing	Exclusion zones around MODUs and platforms; effects of discharges and spills on fishery species; disruption of fishing by spill response and cleanup activities Routine activities: **Minor** Small spills: **Minor** Large spill: **Moderate**	—	—	—	—	—	—	—
Archaeological and Historic resources	Potential impacts to shipwrecks and submerged archaeological resources avoided by conducting archaeological surveys and assessments; a large spill could contaminate coastal historic and prehistoric sites Routine activities: **Negligible** Small spills: **Minor** Large spill: **Moderate**	Slightly reduces risk of impacts to archaeological resources - all of the excluded blocks are sensitive for historic and/or pre-historic resources	—	—	Slightly reduces risk of impacts to archaeo-logical resources - all of the excluded blocks are sensitive for prehistoric resources	—	—	—

Resource	Impacts of Alternative 1 (Proposed Action)	Important Differences Relative to Alternative 1 (Proposed Action)[1]						
		Alternative 3A Beluga Whale CH Exclusion	Alternative 3B Beluga Whale CH Mitigation	Alternative 3C Beluga Whale CH and Near Shore Feeding Areas Mitigation	Alternative 4A Northern Sea Otter CH Exclusion	Alternative 4B Northern Sea Otter CH Mitigation	Alternative 5 Gillnet Fishery Mitigation	Alternative 6 Prohibition of Drilling Discharges
Areas of special concern	Short-term and localized impacts from routine activities; negligible impacts from small spills; large spills could cause extensive and persistent contamination of shorelines Routine activities: **Minor** Small spills: **Negligible** Large spill: **Major**	—	—	—	—	—	—	—
Oil and gas and related infrastructure	Possible damage to subsea pipelines and cables avoided by conducting geohazards surveys; onshore infrastructure is adequate to support exploration and development; large spills could temporarily shut down existing operations Routine activities: **Negligible** Small spills: **Negligible** Large spill: **Minor**	—	—	—	—	—	—	—
Environmental justice	No disproportionately high and adverse impacts on environmental justice communities from routine activities and small spills; large spills could have disproportionately high and adverse impacts on environmental justice communities. Routine activities: **N/A**[2] Small spills: **N/A**[2] Large spill: **Disproportionately High and Adverse**	—	—	—	—	—	—	—

[1] Blank cells (—) indicate impacts are essentially the same as for the Proposed Action.

[2] Analysis of the impacts of the Proposed Action found no disproportionately high and adverse (i.e., major) impacts for routine activities or small spills for any subsistence resource, subsistence harvest patterns, public and community health, and sociocultural systems. Environmental justice analyses only consider disproportionately high and adverse (i.e., major) impacts (CEQ, 1997a). Therefore, routine activities and small spills do not apply to environmental justice analysis in this EIS because they are not anticipated to cause major impacts.

CH = Critical Habitat

Chapter 3

Description of the Affected Environment

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Chapter 3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. Physical Environment

3.1.1. Climate and Meteorology of Cook Inlet

The continental subarctic climate in the Cook Inlet proposed Lease Sale Area is characterized by cold temperatures in winter and cool temperatures in summer. Terrestrial areas bordering the Cook Inlet are classified as Dsc and Dfc under the Köppen-Geiger Climate Classification System (Peel, Finlayson, and McMahon, 2007). The Köppen-Geiger Climate Classification System delineates climate zones based on a combination of native vegetation, average annual and monthly temperatures and precipitation, and the seasonality of precipitation. Areas classified “Ds” are those that exhibit cold climates, with a dry summer season. Areas classified “Dfc” have cold climates with no dry season and short, cool summers. Climate in the Cook Inlet is influenced by the regulating effect of nearby ocean waters, and the seasonal distribution of sea ice. Locations under the predominant influence of the sea are characterized by relatively small seasonal temperature variability, with high humidity.

Ambient temperatures in the Cook Inlet vary based on elevation, proximity to the coastline, and, to some extent, latitude, although the proposed Lease Sale Area is relatively small and is situated over a very narrow range of latitude, spanning approximately 59° to 60°N. Annual and seasonal average temperatures in Cook Inlet and surrounding coastal areas are shown in Table 3.1.1-1. Temperatures are typically coldest in January and warmest in July, with freezing temperatures recorded every month of the year (NCDC, 2015).

Table 3.1.1-1. Cook Inlet Meteorology

Parameter	Time Period	Station			
		Anchorage	Homer	Kenai	Kodiak
Mean Temperature (°F)	Annual	37.0	38.7	36.1	40.9
	January	17.1	24.8	16.5	30.5
	July	58.8	54.6	56.4	54.5
Maximum Temperature (°F)	Annual	43.7	45.3	44.8	46.2
	January	23.1	30.8	24.8	35
	July	65.4	61.2	64.2	59.8
Minimum Temperature (°F)	Annual	30.3	32.0	27.4	35.5
	January	11.1	18.8	8.1	25.9
	July	52.2	48	48.5	49.2
Mean Precipitation (inches)	Annual	16.6	24.3	18.2	78
	January	0.73	2.63	0.96	8.29
	July	1.83	1.55	1.84	4.93
Mean Snowfall (inches)	Annual	74.5	47.4	67.5	68.9
	January	11.3	9.1	9.8	13
	July	0	0	0	0

Source: NCDC. 1981-2010 Climate Normals. Accessed on March 1, 2016. Available on the National Oceanic and Atmospheric Administration (NOAA) Website at http://www.ncdc.noaa.gov/cdo-web/datatools/normals

Wind

Wind speeds and wind directions in the Cook Inlet vary by season and are influenced highly by extreme variability in local topography in the Cook Inlet area (Olsson and Liu, 2009; NCDC, 2015a). When deep synoptic-scale low pressure systems interact with the varied terrain of Cook Inlet, fast-moving air in the lower level of the atmosphere can gust to 95 knots (kn) (109.3 miles per hour (mph)). The wind may flow "down inlet" from the upper Cook Inlet while cross-channel east winds occur in the lower Cook Inlet causing convergent winds. Conversely, "up inlet" winds combine with cross-channel winds to produce divergent wind conditions. Mountain-gap winds create williwaws (sudden and violent blasts of wind descending from a mountainous coast to the sea), and waterspouts that can create hazardous conditions for mariners and aviators (USDOI, MMS, 2003). Mountain-gap winds are most prevalent in winter and can reach nearly 100 kn (115.1 mph).

Prevailing winds in Cook Inlet are from the south in summer months, and are otherwise from the north and northeast. Mean monthly wind speed in Kenai is lowest in August (7 kn (8.1 mph)), and increases slightly through the following months to a maximum of 8 kn (9.2 mph) in June. Extreme maximum wind in Kenai of 62 kn (71.3 mph) in November may constitute a violent storm on the Beaufort Scale (NOAA, 2015a). The extreme maximum wind in Homer has occurred in December when hurricane force winds of 68 kn (78.3 mph) were recorded. Monthly winds in Homer average 1 kn (1.2 mph) in July, reach an average annual maximum in November of 24 kn (27.6 mph).

Precipitation

The inlet experiences annual precipitation averaging 42 cm (16.6 in.) in the north to an annual average of approximately 2 meters (m) (78.0 in) in Kodiak. The inlet is a region of meteorological extremes due to the proximity of the Shelikof Strait and the Gulf of Alaska, which are subject to forceful marine extratropical cyclones. These storms move east along the Aleutian Islands from the western Pacific and are impeded by mountainous terrain, which causes dangerous wind conditions (NOAA, 2012). These conditions are possible in Cook Inlet due to the "maritime-continental gradient," an area of transition from strictly marine climate characteristics (south and east coastal rainforests), and a continental climate (north and west to the Alaskan interior). Typical annual precipitation values are shown in Table 3.1.1-1. In the north, precipitation is lowest in the spring and highest in August and September. In the south, precipitation is lighter than in the north, with least amounts falling in May through August, and much larger amounts than in the north falling in November through January. Snowfall typically occurs from October through April, but may occur as early as September and as late as May. The majority of snowfall occurs from November through February.

Storms

Storm-surge development is unlikely in most of lower Cook Inlet due to the rugged topography and steeply sloping seafloor (Wise, Comiskey, and Becker, 1981). However, the open-water stretch from Shelikof Strait to lower Cook Inlet can develop storm surges with west-southwest winds during the fall and winter when wind strength is sufficient, and many of the storms crossing the North Pacific end up crossing the Aleutian chain and move into the coastal area of the Gulf of Alaska. Storms with wind speeds >45 meters per second (m/s) (100.6 mph) are observed occasionally in mountainous coastal areas due to the change in atmospheric pressure between interior Alaska and the Gulf of Alaska. Wind speeds can be further increased as winds funnel through narrow mountain passes (USDOI, BOEM, 2012b). Severe weather events, such as floods, hail, high winds, and winter events such as heavy snow, ice storms, winter storms, and blizzards have been reported in the area surrounding Cook Inlet (NCDC, 2015b).

Atmospheric stability is a measure of the atmosphere's tendency to encourage or deter vertical motion. Stability varies in the subarctic based on time of day, season, and land surface cover. Vertical stability has an effect on air quality conditions. Dispersion and vertical mixing of pollutants are enhanced in an unstable atmosphere, where pollutants rise and mix freely with otherwise unpolluted air, which decreases surface pollutant concentrations and impacts. Conversely, stable air enhances subsidence, or slow sinking air, which concentrates the pollutants and increases surface pollutant concentrations and impacts; this is referred to as inversion, and the highest elevation of the inversion is referred to as mixing height.

Cook Inlet exhibits frequent high winds and cloud cover, which cause a predominantly neutral atmospheric condition. The atmosphere is unstable 10% of the time, and stable the other 90% of the time (Doty, Wallace, and Holzworth, 1976). Mixing heights over land go through progressively larger diurnal and seasonal variations farther inland due to increased solar heating and surface cooling. Mixing heights are generally lowest around sunrise and highest in the afternoon, and, seasonally, mixing heights are typically highest in summer and lowest in winter. For coastal areas of Alaska, average mixing heights range from 1,000 to 1,400 meters (3,280 to 4,590 ft). Mixing height over land reaches a maximum in the late afternoon, and reaches a minimum during clear, calm conditions at night in the winter when it can be close to zero (Wang and Wang, 2014).

3.1.1.1. Climate Change

Current Climate Change Trends

The Earth's climate system is driven by the Sun's incoming solar energy, which is reflected, absorbed, and emitted from the surface and within the Earth's atmosphere (i.e., by clouds and other gases), and the resulting energy balance determines the temperature of the atmosphere (Solomon et al., 2007). Atmospheric gases, primarily water vapor and carbon dioxide (CO_2), act like a blanket over the Earth, absorbing infrared (IR) solar radiation and preventing the escape of heat back into outer space. The net effect can cause a net change in the temperature of the global atmosphere over time. Warming of the atmosphere occurs because of the "greenhouse effect," and the gases responsible for the effect are termed "greenhouse gases" (GHGs). The primary greenhouse gases, mostly emitted as a result of industrial activity and the combustion of fossil fuels, are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The climate system's response to positive radiative forcing is complicated by several positive and negative feedback processes among atmospheric, terrestrial, and oceanic ecosystems, but overall the climate is warming, as is evident by observed increases in air and ocean temperatures, melting snow and ice, and sea level rise (Intergovernmental Panel on Climate Change (IPCC), 2014).

Global concentrations of atmospheric GHGs have increased significantly from pre-industrial times. Increasing emissions are linked to human activity sectors including energy, industry, transportation, and agriculture, and emissions are increasing at a greater rate in the last decade (2.2% per year) than in the preceding three decades (average of 1.3% per year), despite the implementation of various climate change mitigation policies (IPCC, 2014).

The IPCC (2014) report states with high confidence that approximately 78% of the total increase in GHG emissions from 1970 to 2010 come from fossil fuel combustion and industrial processes. IPCC has concluded that the global average surface temperature has increased throughout the 20th century, with a linear trend showing a warming of 0.85°C (1.53°F) over the period 1880 to 2012, interrupted by a cooling trend between 1945 and 1976. In Alaska and throughout the Arctic, temperatures are believed to have fluctuated considerably over the last few centuries (Mann, Bradley, and Hughes, 1999), but the IPCC found it extremely likely (95-100% probability) that over 50% of the observed increase in global average surface temperature from 1951 to 2010 was caused by anthropogenic (originating from human activity) factors. The United Nations Framework Convention on Climate Change (UNFCCC) similarly suggests that climate change is attributable to human activities that have caused climate variability beyond what can be explained by natural causes, by altering the composition of the atmosphere (IPCC, 2014).

3.1.2. Physiography, Bathymetry, and Geology

3.1.2.1. Physiography

The geologic history of the Cook Inlet region recently has been summarized in Wilson and Hults (2012). The Cook Inlet basin was formed by plate-subduction tectonics (Bradley et al., 1997; Bunds, 2001; Plafker, Moore, and Winkler, 1994). The structural low of the basin and the mountains surrounding it have been sculpted into their present morphology primarily by the direct or indirect action of glaciers (Karlstrom, 1964; Miller and Dobrovolny, 1959; Wilson and Hults, 2012).

3.1.2.2. Bathymetry

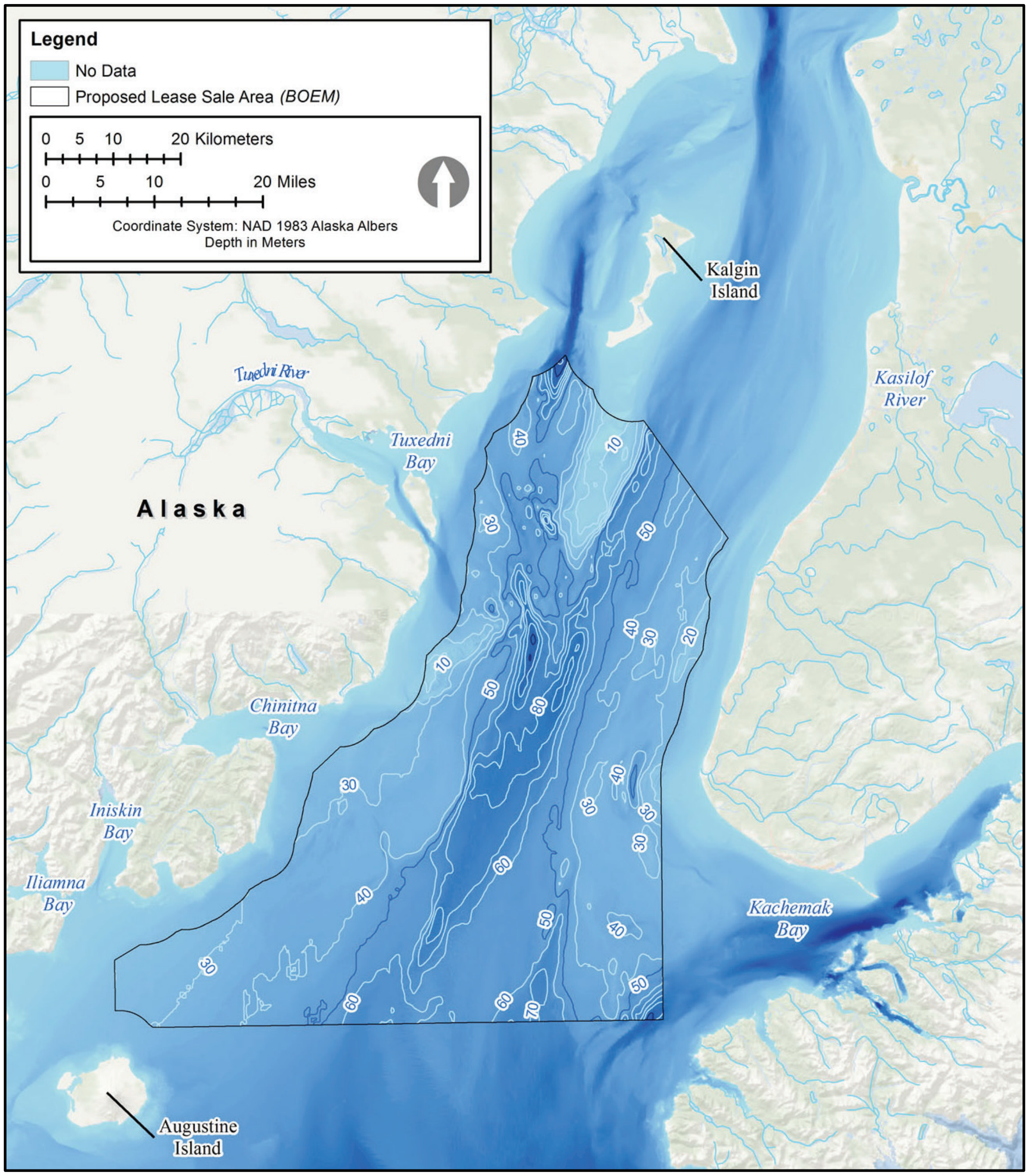


Figure 3.1.2-1. Cook Inlet Bathymetry in the Proposed Lease Sale Area. *Source: Zimmerman and Prescott, 2014.*

The Cook Inlet embayment projects north-northeast for >240 km (149 mi) into the southcentral Alaskan coast. It narrows to the north from a maximum width of 140 km (87 mi) near Kamishak and Kachemak Bays, to 50 km (31 mi) near Kalgin Island. The inlet lies between the Chugach and Kenai

Mountains on the southeast, the Talkeetna Mountains on the northeast, and the Alaska-Aleutian Range on the northwest. Lower Cook Inlet is connected to the southwest through Shelikof Strait, which extends for another 270 km (168 mi) to join the North Pacific Ocean. To the southeast, the inlet opens to the Gulf of Alaska through the Stevenson and Kennedy Entrances that flank the Barren Islands.

Thurston and Choromanski (1995) divided lower Cook Inlet into four provinces, each dominated by a distinct set of processes:

- Province I, 0 to 60 m (0 to 197 ft) depth: constructional morphology, glacial deposition, and subordinate erosion
- Province II, 60 to 120 m (197 to 394 ft) depth: constructional morphology, glacial and marine deposition with subordinate hydraulic erosion
- Province III, 120 to 190 m (394 to 623 ft) depth: erosional morphology, gently sloping seafloor formed by glacial erosion and subordinate glaciomarine deposition; and
- Province IV, deeper than 190 m (623 ft): erosional morphology, closed basins formed by glacial erosion and subordinate glaciomarine deposition

Provinces I and II correspond to the area of the northern bathymetric tier and ramp, the location of the proposed Lease Sale Area for the current Draft EIS. Provinces III and IV correspond to the southern bathymetric tier and Shelikof Strait. The northern part of lower Cook Inlet has thick deposits of glacial, glaciofluvial, and glaciomarine strata. The ramp is the bathymetric manifestation of merging terminal moraines and other morainal lobes deposited by ice from Kachemak and Kamishak Bays, and larger glaciers moving southwest down the inlet. The bathymetric profile of the southern plateau and Shelikof Strait reflects deep scour by glaciers, and thin Pleistocene and Holocene marine and glaciomarine sediment cover (Thurston and Choromanski, 1995).

In Federal waters, bathymetric relief ranges from <10 m (33 ft) near Kalgin Island in the north to 70 m (230 ft) along the ramp from Augustine Island to Seldovia (Figure 3.1.2-1). Lower Cook Inlet generally is configured as a two-tiered plateau, with the shallower (<90 m (295 ft) deep) northern part separated from the deeper (>90 m (295 ft) deep) southern part by the ramp (Bouma, Hampton and Orlando, 1977; Whitney et al., 1979). The northern tier is dissected by a 45-m (148 ft) deep central valley, which divides in the north around Kalgin Island, and forms the Kachemak Channel in the center of Kachemak Bay. This northern plateau is covered with various bedforms including sand waves with amplitudes approaching 15 m (49 ft) (Thurston and Choromanski, 1995; Whitney et al., 1979).

Average water depth generally increases from north to south in Cook Inlet. Between Fire Island and the Forelands, upper Cook Inlet has an average depth of approximately 18.3 m (60 ft). Central Cook Inlet, from the Forelands to Kachemak Bay, has an average depth of about 27.4 m (90 ft). The average depth from Kachemak Bay to the inlet mouth of the Barren Islands is approximately 36.6 m (120 ft). Notably, constrictions are caused by islands and prominences at the Barren Islands, Augustine Island, Homer Spit (the mouth of Kachemak Bay), Kalgin Island, the East and West Forelands, at Middle Ground Shoal north of the Forelands, and Fire Island at the confluence of Knik and Turnagain Arms.

3.1.2.3. Geology

Quaternary Geology

A Quaternary unconformity is present throughout the proposed Lease Sale Area (Thurston, 1985). The surface formed as ice flowing along the Cook Inlet depression eroded underlying rock, characterized by truncated and tilted Tertiary strata overlain in the north by unstratified or poorly stratified moraine or till deposits, and by stratified glaciofluvial, glaciomarine, and marine sediments in the south. The relative depth of the unconformity is a direct measure of the intensity of ice erosion and, by inference, ice depth. The area of thickest Quaternary deposits also occurs where the unconformity is deepest (Thurston, 1985).

Seafloor sediments have been sampled and their distribution mapped (Bouma, Hampton, and Orlando, 1977). In general, the northern area is mantled by coarse sand and gravel, while the mid-inlet is covered by fine- to medium-grained sand sculptured into bedforms. Quartz grains in the northern part of Lower Cook Inlet have unaltered glacial affiliation (Hampton et al., 1978). Quartz grains in the central sand-wave area show characteristics of glacial deposits altered by hydraulic reworking. Seafloor sediments in the west and south show chemical overgrowth over a glacial texture, which indicates lengthy residence in a low-energy environment. Sedimentary deposits and bedforms are summarized in Table 3.1.2-1.

Table 3.1.2-1. Sedimentary Deposits and Bedforms, Cook Inlet.

Deposit or Bedform	Location in Cook Inlet	Description and Comments
Surface Features		
Lag gravel	Northern Lower Cook Inlet near Kalgin Island	Deposited by glaciers and subsequently winnowed. Deposits display textures associated with unaltered glacial sediment (Hampton et al., 1978).
Sand ribbons	Northern and central Lower Cook Inlet	Strips of sand oriented generally north-south, parallel to prevailing tidal currents, separated by lag gravel. Support sand ripples, oriented transverse to current direction, in areas flanking the sand wave field and the Central and Kachemak Channels.
Lower Cook Inlet Sand Wave Field	Lower Cook Inlet	Bedforms reaching amplitudes of 15 m (49 ft) and wavelengths of 600 m (1,969 ft), occurring in water depths ranging to >120 m (394 ft). No evidence that these migrate, neither is there evidence for any net sediment transport (Whitney et al., 1979; Whitney, Noonan, and Thurston, 1981). Sand wave field covers approximately 850 km^2 (328 mi^2) of seafloor.
Subsurface Features		
Terminal moraine	Kalgin Island	Deposited from ice lobe that flowed east from the Alaska Range into Redoubt Bay (Thurston and Choromanski, 1995).
Ground moraine and till deposits	Northern Lower Cook Inlet	Unstratified, mounded, and heavily dissected strata, having several stratigraphic intervals.
Ramp (Bouma et al. 1978)	Southern end of proposed Lease Sale Area	Inverted V-shape in map view, with bathymetric relief of >60 m (197 ft). Represents the juncture of two moraines: Kamishak Bay Moraine Complex forms the western limb, and Kachemak Bay Moraine forms the eastern limb (Thurston, 1985).
Delta-type outwash fans	Apex of ramp (juncture of Kamishak and Kachemak Moraines)	Fans formed as glacial outwash streams deposited their sediment bedload at the paleoshoreline. Based on present depth, fans formed at the paleoshoreline during sea level lowstand or stillstand 65 to 80 m (213 to 262 ft) below modern sea level, with ages of 12,700 to 15,000 years before present.
Large sand waves	Apex of ramp	Large sand waves buried beneath outwash and glaciomarine deposits.
Sand waves	Central Cook Inlet	May have formed at lower sea level stands and subsequently stranded in deep water by a rapid rise in sea level after the last major ice advance.
Buried discontinuous and branching channels	Area of the proposed lease sale, and near apex of ramp, but absent to south	Predominantly glacial channels (U-shaped profile, wider and more continuous hydraulic channels); also tunnel valleys (sub-ice glacial drainage channels with eskers), and glacial outwash stream channels.
Ice scour	Shelikof Strait and adjacent continental shelf	Ice completely filled Shelikof Strait and spilled out to the continental shelf during the Moosehorn and Killey advances.
Ice-rafted boulders and comet marks	Lower Cook Inlet	Last ice retreating from the trough formed tidewater glaciers.

Tectonic Setting and Geologic Hazards

Subduction of the Pacific Plate beneath the North American Plate is demarcated by the Aleutian Trench, extending approximately 3,400 km (2,113 mi) from the northern end of the Kuril-Kamchatka Trench to the northern end of the Queen Charlotte Fault System. North of the trench is the volcanic Aleutian Chain, an island arc. Active volcanism extends about 2543 km (1,580 mi) eastward from Buldir Island in the Aleutian Chain, and then northeastward along the Alaskan Peninsula and the western side of Cook Inlet to the Wrangell Mountains (Coats, 1962; Zimmerman, Neal, and Haeussler, 2008).

A variety of geologic hazards are associated with convergent, subduction zone plate settings. Earthquakes are potentially hazardous, with damage increasing as a function of the amount of stored seismic energy released, proximity to the epicenter, length of event, direction of rupture, and underlying geology, which may dampen or amplify seismic waves. A number of hazards can be associated with earthquakes, including:

- Seismic shaking, with attendant damage to infrastructures
- Tsunami
- Liquefaction
- Vertical displacement (uplift and subsidence)
- Mass movements, including submarine mass movements and turbidity currents

Eruptions of island arc volcanoes are potentially hazardous for a number of reasons. Heavy ash falls can collapse buildings, damage vegetation, clog sewer systems, and damage infrastructure (Zimmerman. Neal, and Haeussler, 2008), or cause respiratory distress. Hazards anticipated with island arc volcanism include:

- Ash clouds and ash falls
- Pyroclastic flows, avalanches, or surges with attendant widespread destruction possible
- Tsunami
- Lahars, mudflows, debris avalanches or other types of mass movements, including submarine mass movements and turbidity currents
- Emissions of acidic or toxic gases or acidic hydrothermal waters, and
- Ballistic production (pebble- to boulder- sized projectiles that can be thrown several km (mi) from the site of an eruption)

Seismicity

Alaska is the most seismically active of all U.S. states (Zimmerman, Neal, and Haeussler, 2008), with approximately 24,000 seismic events occurring annually, and a single earthquake of magnitude 7 (M7) or greater occurring approximately every two years. The vast majority of events are microquakes, with M <2, but six megathrust earthquakes of magnitude M >8 have occurred along the Alaska-Aleutian subduction zone since 1906, including the Great Alaska Earthquake of 1964, with a moment magnitude (M_W) of 9.2 (Table 3.1.2-2) (Benz et al. 2011). Recent research indicates that low-frequency earthquakes characterized by 10- to 20-minute (min) long tremor bursts appear to mark the down-dip rupture limit for great megathrust earthquakes in this subduction zone (Brown et al., 2013). Peak horizontal accelerations of 0.30 and 0.40 gravitational acceleration (g) have a 10% probability of exceedance in 50 years in the Cook Inlet area (Wesson et al., 1999).

The Great Alaska Earthquake, with an epicenter situated in Prince William Sound about 120 km (75 mi) from Anchorage, was the second strongest earthquake ever recorded, and the strongest U.S. earthquake (Brocher et al., 2014). Most of the Alaskan population was affected by this quake, as major transportation routes, ports, and infrastructure are comparatively close to the Prince William epicenter of (Brocher et al., 2014).

Seismic shaking was felt across an area of approximately 1.3 million km^2 (500,000 mi^2) (Grantz, Plafker, and Kachadoorian, 1964). The subsurface rupture was associated with uplift of the continental shelf to the south of Kodiak and Seward, while Kodiak Island, the Kenai Peninsula, the Kachemak Bay, and all of the Cook Inlet underwent tectonic subsidence ranging approximately 0.6 to

2.5 m (2.0 to 8.2 ft) (Freymueller et al., 2013). Vertical deformation occurred over an area of approximately 250,000 km^2 (100,000 mi^2) (Alaska Earthquake Center (AEC), 2015a). The most destructive tsunami of U.S. history occurred as a result of this quake, and 131 lives in Alaska, Oregon, and California were lost as a result. Maximum tsunami run-up height was 70 m (230 ft), in Valdez Arm, Alaska (AEC, 2015a). Widespread liquefaction contributed to damage in the Turnagain Arm. Much of Anchorage was damaged, in part because the Quaternary glacioestuarine Bootlegger Cove clay failed. Anchorage, now home to approximately 275,000 people, was rebuilt largely on unstable regolith: glacial drift, and glaciofluvial and ice contact deposits.

Table 3.1.2-2. Great Megathrust Earthquakes, Alaska-Aleutian Subduction Zone Since 1900.

Location of Great Megathrust Earthquake	Year of Event	Moment Magnitude (MW)
Rat Islands	1906	8.4
Shumagin Islands	1938	8.6
Unimak Island	1946	8.6
Andreanof Islands	1957	8.6
Kodiak Island/Prince William Sound[1]	1964	9.2
Rat Islands	1965	8.7

Notes: [1] The Great Alaskan (“Good Friday”) Earthquake.
Source: Benz et al., 2011.

Grantz, Plafker, and Kachadoorian (1964) reported that the oil refinery, tanks, and docks at Nikiski sustained some damage, but production was not significantly delayed. Wells in the Swanson River oil field and the Kenai gas field were reportedly not damaged, but some leaks and breaks did occur in pipelines.

While most Alaskan seismic events are associated with the Aleutian-Alaska Megathrust (Table 3.1.2-2), seismic events also occur in interior Alaska where tectonic stresses are translated from the plate boundary (AEC, 2015b). These earthquakes are concentrated along several major faults.

The most recent significant earthquake of this type was the M_w 7.9 Denali Fault quake of 2002. In Anchorage, 283 km (176 mi) south, this earthquake had an intensity of IV. The Denali Fault quake, the strongest ever recorded in interior Alaska, began with thrusting on a previously unknown fault (now called the Susitna Glacier Fault). Total rupture length was 330 km (206 mi). Maximum horizontal rupture was 8.8 m (29 ft); landslides and liquefaction accompanied this event (U.S. Geological Survey (USGS), 2003).

Additionally, in the Cook Inlet region, seismicity may be associated with the numerous, discontinuous anticlinal folds, transpressive structures resulting from active deformation. Haeussler, Bruhn, and Pratt (2000) suggested that if other structures in Cook Inlet were active, blind faults coring fault-propagation folds might generate M_w 6 to >7 earthquakes.

Work is ongoing to determine the recurrence interval for megathrust earthquakes along the Alaska-Aleutian subduction zone (Kelsey et al. 2013; Praet et al., 2014). According to the AEC of the University of Alaska, Fairbanks which collects seismic data at >400 sites across the state, both the Yakuta Gap and the region between Kodiak Island and Shumagin Island are sites where earthquakes of M >8 “are expected” (AEC, 2015b), although probabilities for such quakes were not specified.

Volcanism

There are more than 40 active Alaskan volcanoes along the Aleutian arc (Waythomas et al., 1998). One to five eruptions occur annually, based on historic records spanning the past two centuries (Zimmerman, Neal and Haeussler, 2008). Eruptions of volcanoes bordering Cook Inlet have occurred every 10 to 35 years in the 20th century. Studies of tephras (ash deposits) accumulated over the past 500 years suggest recurrence at least every 50 to 100 years.

Three of the Aleutian Arc active stratovolcanoes occur inland of the western boundary of Cook Inlet; another volcano, the Augustine, is located in the lower Cook Inlet. From north to south, these are the Mt. Spurr, Redoubt, Iliamna, and Augustine Volcanoes. In the past 200 years, all but Iliamna have erupted several times. Eruptions of these volcanoes have generated ash clouds and ash falls, and promoted mass movements, including lahars (mudflows formed from mixtures of volcanic ash, surface materials, and meltwaters, created when snows on a volcano melt during an eruption).

Augustine Volcano has been the most active over the past 500 years (Stevens and Craw, 2004), and its ashfalls have blanketed portions of the Cook Inlet region with several mm of ash (Waythomas and Waitt, 1998). In the past 2,000 years, Augustine's eruptions have been associated with eleven flank-failure debris-avalanches large enough to reach the coast of the island and enter the sea (Maharrey, Beget, and Wallace, 2014). An 1883 eruption of the Augustine volcano caused a debris avalanche that generated a tsunami run-up of 8 m (26 ft) that inundated the indigenous Alaskan village of Nanwalek (previously English Bay) 85 km (53 mi) away (Maharrey, Beget, and Wallace, 2014; Waythomas and Waitt 1998;). Tsunami deposits in a peat exposure on the shoreward edge of the English Bay headland correspond with Augustine tephra marker horizons dated approximately 1,400 years before present (B.P.), 1,700 B.P., and 2,100 B.P. (Maharrey, Beget, and Wallace, 2014).

Both the Redoubt and Mt. Spurr Volcanoes have emitted ash clouds with the potential to compromise air travel (Kienle, 2000). During the 2009 Redoubt event, ash clouds reached approximate heights of 20,000 m (65,617 feet) on March 26. During the 1989 to 1999 Redoubt eruption (the second most costly in U.S. history) ejected volcanic ash reached a height of about 14,000 m (45,932 ft). Following the 1989 eruption, airports in Anchorage and on the Kenai Peninsula were closed for several days; advected ash clouds disrupted air traffic as far away as Texas (Przedpelski and Casadevall, 1994). Respiratory issues increased in some Alaskan residents as a result of ash (Waythomas et al., 1998).

Lahars occurred during the 1965 to 1968, 1989 to 1990, and 2009 Redoubt eruptions. These flooded the Drift River Valley, and some eventually reached Cook Inlet. Because lahars partially inundated the Drift River Oil Terminal 35 km (22 mi) away on the Kenai Peninsula in January 1990 (Waythomas et al., 1998), the facility was closed during the 2009 eruptions. Three lahars (March 23, March 26, and April 3, 2009) reached Cook Inlet and the Drift River Oil Terminal (Bull and Buurman, 2013), but damage was minimal, although large oil storage tanks were endangered (McNutt and Eichelberger, 2012).

3.1.3. Physical Oceanography

3.1.3.1. Physical Oceanographic Environment

Cook Inlet is a complex Gulf of Alaska estuary. An estuary is defined as a semienclosed coastal body of water having a free connection to the open sea and within which the seawater is measurably diluted with freshwater deriving from land drainage (Cameron and Pritchard, 1963). Cook Inlet has marine connections with Shelikof Strait and the Gulf of Alaska, has terrestrial freshwater sources from rivers, and is characterized by estuarine-like circulation (Muench, Mofjeld, and Charnell, 1978).The physical oceanography of Cook Inlet is characterized by complex circulation with variability at tidal, seasonal, annual and interannual timescales (Musgrave and Statscewich, 2006). As this region has the fourth largest tidal range in the world, the circulation is dominated by tidally driven flows, with current speeds up to 3 m/s (6 kn) (Musgrave and Statscewich, 2006). Middle Cook Inlet is a dynamic region with significant sub-tidal circulation, including a south-flowing, buoyancy-driven current along the western shore (Johnson and Okkonen, 2000). Knowledge of the tidal and subtidal currents in Cook Inlet is essential for determining and predicting transport pathways as they play a critical role in affecting potential pollutants and the fate of spilled oil (Musgrave and Statscewich, 2006).

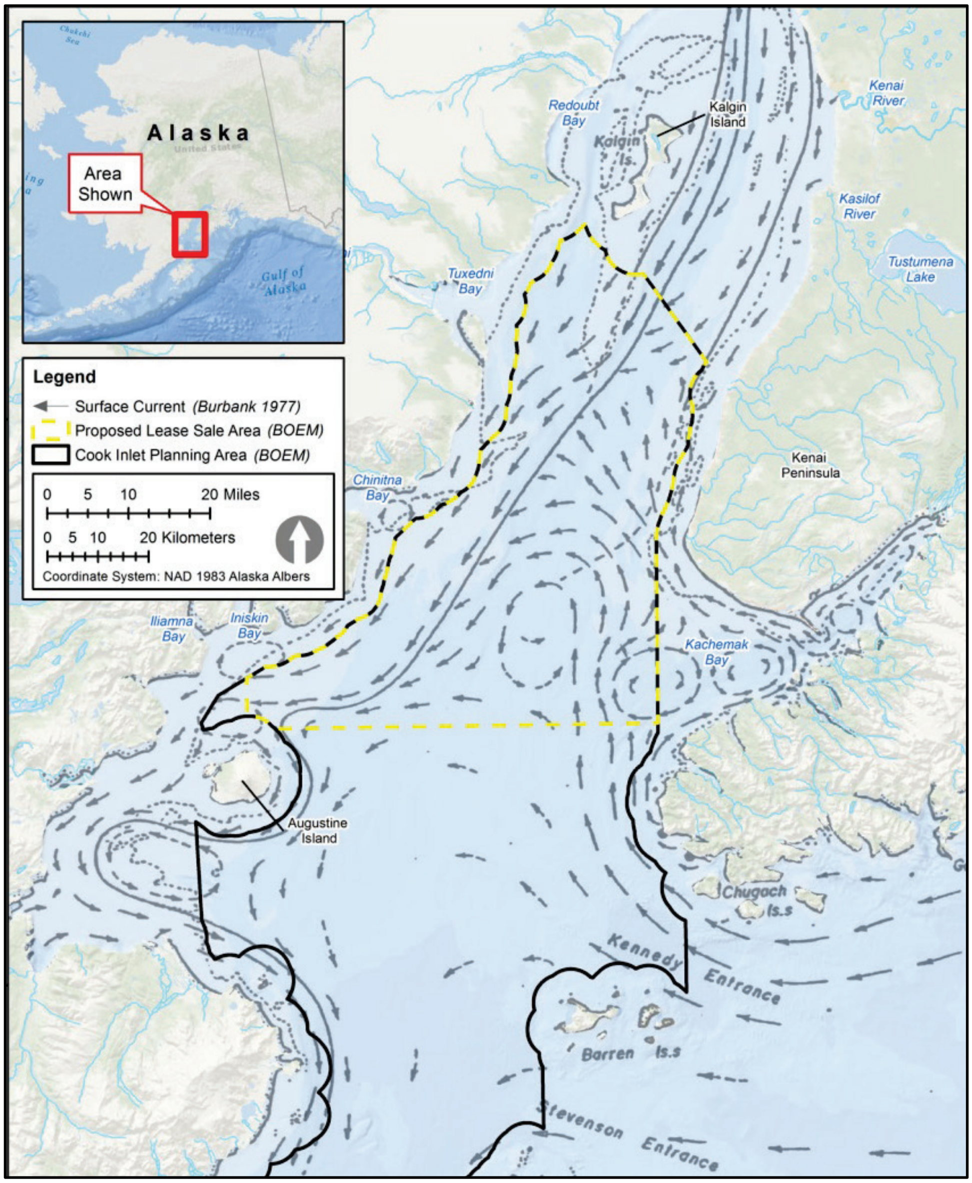


Figure 3.1.3-1. Predominant Currents in Cook Inlet. Modified from: Burbank (1977).

Predominant Currents and Cook Inlet Water Circulation

Direction of the predominant surface currents are depicted in Figure 3.1.3-1. Strong tidal currents drive the circulation in the greater Cook Inlet area. The general circulation pattern of lower and middle Cook Inlet is characterized by denser, saltier water that flows northward along the eastern shore and fresher, silty outflowing water moving southward along the western shore (LGL Alaska Research Associates, Inc., 2000).

More specifically, the Alaska Coastal Current (ACC) flows along the inner shelf in the western Gulf of Alaska, and northward along the eastern side of Cook Inlet. Relatively fresh and turbid upper Cook Inlet outflow meets and mixes with incoming ACC water in the central inlet, flowing along western Cook Inlet, and outflowing to Shelikof Strait (LGL Alaska Research Associates, Inc., 2000). Regional circulation in lower Cook Inlet is strongly influenced by the east to west flow of the ACC in the Gulf of Alaska. The ACC becomes entrained into the strong inflow to Cook Inlet in the vicinity of Kennedy and Stevenson Entrances. Nutrient-rich bottom water upwells over the shelf break, and mixes with surface water. These nutrient enriched waters are trapped along the coast, and stream into Kachemak Bay following the bathymetric contours of the relict fjordal trough. Nutrient-rich waters upwelled and entrained by the ACC enter the outer Kachemak Bay and contribute to high productivity (Burbank, 1977; Lees et al., 1980) (Figure 3.1.3-1).

3.1.3.2. Water Depth and Bathymetry

Overall, Cook Inlet is shallow, with an area-weighted mean depth of 44.7 m (148 ft), but is as deep as 212 m (695 ft) at the south end near the Barren Islands (Alaska Fisheries Science Center (AFSC), 2014). The bathymetry of middle Cook Inlet is characterized by two 50 to 100 m (164 to 328 ft) deep troughs located in the center of the inlet, and on the western side of Kalgin Island (Musgrave and Statscewich, 2006). Bathymetry of Cook Inlet is further discussed in Section 3.1.2.2.

At mean high water (MHW), the total volume of the inlet is 1,024.1 km^3 (245.7 mi^3) with a total surface area of 20,540 km^2 (7,931 mi^2) (AFSC, 2014). When the tide drops from MHW to mean low water (MLW), the inlet loses 99.7 km^3 (23.9 mi^3) of water, or 9.7% of its volume, and exposes 1,616 km^2 (624 mi^2) of seafloor, or 7.9% of its surface area. The majority of these tidally exposed areas are in Knik and Turnagain arms, the Susitna River area, and near the West Foreland. Between MLW and a depth of 10 m, the volume is 176.3 km^3 (42.3 $miles^3$) (or 17.2%) but covers 2,563 km^2 (990 $miles^2$) (or 12.5%). Thus, the shallows (MHW to <10 m) contain one-fifth of the inlet's volume and over one-quarter of its surface area. Depths >50 m (164 ft) occupy the central core of the inlet and extend in narrow bands past Kalgin Island; they also occur in small areas within Kamishak Bay and in about half of Kachemak Bay. Depths >100 m (328 ft) occur almost entirely at the entrance to the inlet, where about 10.1% of the total volume occupies 11.7% of the surface area.

3.1.3.3. Water Temperature and Salinity

Water temperature and salinity gradients exist both seasonally and geographically between lower and central Cook Inlet, and between the east and west sides of the inlet. Temperatures and salinities are negatively correlated during the summer months, whereas they are positively correlated during the winter months (Okkonen, 2005). The temperature and salinity gradients between and across lower and central Cook Inlet, suggest five principal factors necessary for accurate numerical simulations of Cook Inlet hydrography and circulation. These conditions include accurate spatial and/or temporal representations of (1) freshwater discharges into Cook Inlet (e.g. Susitna River, Matanuska River, Kenai River, and other river discharges to Cook Inlet), (2) heat and salt fluxes through Kennedy Entrance (including ACC transport), Stevenson Entrance, Shelikof Strait, (3) bathymetry, (4) tidal forcing and (5) solar insolation. Although wind forcing is also an important forcing mechanism, it was not directly investigated as part of this project, nor was its role readily discernable from the hydrographic data (Okkonen, Pegau, and Saupe, 2009). Except where otherwise noted, the following discussion regarding temperature and salinity is based on a study by Okkonen, Pegau, and Saupe, (2009), who completed a hydrographic survey along five transect lines across Cook Inlet.

Water Temperature

In March, the water in Cook Inlet begins to warm at a fairly constant rate until July (Okkonen, Pegau, and Saupe, 2009). Water temperature is relatively constant between July and September, with a small peak in August. Beginning in October, water temperature rapidly decreases until December and then remains low until March.

The western side of Cook Inlet has the most extreme temperature changes (Okkonen, Pegau, and Saupe, 2009). Surface waters on the western side of Cook Inlet originate in the upper inlet where very shallow depths promote efficient cooling in winter, and heating in summer, this seasonal cycle occurs throughout lower Cook Inlet waters. The one exception to this pattern occurs in the deepest waters of Shelikof Strait where minimum temperatures may occur in the summer when cold, saline water masses move along the bottom of the Strait. This intrusion of more saline waters is consistent with the salinity signal observed in the Gulf of Alaska, as described by Royer (2005).

Due to the large tidal range and shallow bathymetry of the upper Cook Inlet, waters there warm rapidly in late spring and early summer and cool rapidly during the autumn (Okkonen, Pegau, and Saupe, 2009). Because the lower inlet waters are influenced directly by communication with the northern Gulf of Alaska, lower Cook Inlet mean temperatures are warmer and exhibit less seasonal variability than those in the upper Cook Inlet. The lowest mean temperatures (approximately 5 to 5.5°C (41 to 41.9°F)) and the largest amplitude seasonal temperature signal (approximately 8.5°C (47.3°F)) occurs between the Forelands. Maximum temperature occurs in mid-August. Amplitude of the seasonal signal, while less than that near the Forelands, is relatively large (approximately 6°C (43°F)) on the west side compared to the amplitude (approximately 4°C (40°F)) on the east side.

The temperature maximum in the upper 100 m (328 ft) of the water column occurs in late August to early September (Okkonen, Pegau, and Saupe, 2009). The amplitude of the seasonal temperature signal is approximately 4°C (39.2°F) in the core of the ACC. The amplitude is <1°C (34°F) near the bottom between Shuyak Island and the Barren Islands.

Salinity

Seasonal changes in freshwater inputs drive seasonal changes in the salinity field of Cook Inlet (Okkonen, Pegau, and Saupe, 2009). There are two principal sources of freshwater to the study area: river discharge into upper Cook Inlet, and ACC transport into lower Cook Inlet. A typical seasonal river discharge profile somewhat resembles a step function. Following the winter discharge minimum, river discharge increases by more than an order of magnitude during May. Discharge remains high through the summer, though variable, and decreases from late September through November. While freshwater is carried into lower Cook Inlet throughout the year by the ACC, the freshwater signal varies with seasonal changes in coastal precipitation and wind mixing. The resulting ACC salinity minimum occurs in late September to early October, about a month later than the salinity minimum occurs in central Cook Inlet.

Muench, Mofjeld, and Charnell (1978) measured oceanographic conditions in lower Cook Inlet in the spring and summer of 1973. Surface salinity was lowest on the west side of Cook Inlet, and isohalines generally paralleled the coastline. Salinities in lower Cook Inlet decreased from a range of 30.4 to 31.4 parts per thousand (ppt) in late May (1973) to a range of 26.0 to 30.5 ppt by early September. The highest salinity on the west side of the Inlet was measured in September in southwestern Kamishak Bay. Decreasing salinity through the summer is attributed to river runoff; between 70 and 80% of runoff came from the Susitna, Knik, and Matanuska Rivers into the upper Cook Inlet (Hein et al., 1979).

When Okkonen, Pegau, and Saupe (2009) compared mean salinities in Cook Inlet, they affirmed the known north-south salinity gradient that occurs in Cook Inlet. The north-south salinity gradient is strongest in late summer and early fall, when river discharges and glacial outflows are high.

Most of the largest rivers of the Cook Inlet watershed discharge north of the Forelands. The lowest mean salinities (approximately 26 to 28 ppt) and the largest amplitude seasonal salinity signal (approximately 3 ppt) occur between the Forelands. Mean salinities increase from west to east indicating a mean southward baroclinic flow in the upper part of the water column. Highest salinities at the Forelands occur in mid-February when river discharge is low, while the lowest salinities occur six months later in mid-August, approximately coinciding with the middle of the summer discharge pulse (Okkonen, Pegau, and Saupe, 2009).

Tidal mixing near the mouth of Kachemak Bay during spring tides alters the flow of freshwater into lower Cook Inlet. The lowest salinities occur in September. The broad west-to-east inclination of the isohalines indicates that the mean baroclinic flow is directed southward, out of the inlet into Shelikof

Strait (Okkonen, Pegau, and Saupe, 2009). The most saline waters (>27 ppt) are at the bottom of the shipping channel and in shallow water adjacent to Kalgin Island. The higher salinity values occurring in the shipping channel reflect the northern intrusion of denser water with a more oceanic character. Mean surface flow associated with the core of the Forelands plume is southward, and northward elsewhere (Okkonen, 2005).

3.1.3.4. Tidal Currents and Measurements

Daily changes in tidal ranges, termed diurnal inequality, are due to the moon's declination from the plane of the equator during its orbit around the Earth. Complex interactions between the Earth-moon and sun-Earth astronomical systems are magnified in Cook Inlet, making it difficult to predict tide levels (LGL Alaska Research Associates, Inc., 2000). Surface waves are generated by wind, and stronger winds create larger and more energetic waves. While large waves can occur any time of year, they are more frequent in the winter. Wave energy decreases with depth, and at a depth of about 10 m (33 ft), most wave energy is completely attenuated.

The shape and depth of Cook Inlet is such that the M2 tide (generally the primary component of tide, caused by the moon every 12 hours and 25 minutes) resonates leading to a very large tidal amplitude (Okkonen, Pegau, and Saupe, 2009). Cook Inlet is narrower towards the north causing the tidal amplitude and resulting currents to increase towards the constriction formed by the Forelands (Okkonen, Pegau, and Saupe, 2009). Changes in tidal flow associated with changes in bathymetry form strong shear, and convergence zones locally known as rips which are discussed in Section 3.1.3.6.

Tides wash in and out of the Cook Inlet basin like a long wave. Fluid motion on this large scale is affected by the rotation of the Earth, causing incoming currents in Cook Inlet to veer toward the eastern coast and outgoing currents to veer to the western coast (LGL Alaska Research Associates, Inc., 2000). Twice a lunar month, the tides move from a neap to a spring condition, causing a greater than twofold increase in tidal velocities (Whitney, 2000). Because incoming currents have more energy, tidal ranges on the east shore are generally larger than those on the opposite shore (LGL Alaska Research Associates, Inc., 2000). In the deeper areas of the lower inlet, tidal currents can be modeled as rotary tides. Cotidal lines are lines along which the phase of the tide is equal (i.e., high tide occurs at the same time) (LGL Alaska Research Associates, Inc., 2000). Cook Inlet cotidal lines, from concurrent coastal water level measurements, generally run east to west directly across the waterway. Corange lines, along which the tidal range is equal, are not parallel to cotidal lines in Cook Inlet.

Satellite imagery suggests that horizontal current speeds in Cook Inlet have large and frequent fluctuations, routinely near banks and shoals (LGL Alaska Research Associates, Inc., 2000). These fluctuations create zones of divergence marked by upwelling where water appears to boil on the surface. In summary, Cook Inlet is a high-energy environment with strong tidal currents which are extraordinarily complex and energetic, dominating all other hydrodynamic forces in the waterway. Though other forces such as wind, waves, and ice, may affect the detection of rip tides, tidal forces drive rip tides.

Tidal current ellipses for four major tidal components reveal a strong polarization of tidal currents in the north-south direction, consistent with steering by local bathymetry and orientation of Cook Inlet (Musgrave and Statscewich, 2006). Magnitudes are generally greater and more polarized in the middle portion of the inlet than near the sides for all constituents (Musgrave and Statscewich, 2006). The current flow pattern shows persistent southward currents along the northeast side of Kalgin Island with speeds up to 25 cm s^{-1} (0.5 kn), northward currents in the middle inlet, and southward flow in the middle portion of the eastern inlet (Musgrave and Statscewich, 2006). The monthly averaged currents all show the persistent southward flow along Kalgin Island, but when the winds are strong in a southward direction, the northward flow in the center of the inlet is decreased, and the southerly flow on the middle portion of the eastern side of the inlet is greater (Musgrave and Statscewich, 2006). When the winds are strong in a northward direction, the middle inlet’s northward flow is greater and the southward flow near the middle portion of the eastern side of the inlet is less (Musgrave and Statscewich, 2006). While subtidal current speeds are significantly weaker than tidal currents, they may dominate transport processes at time scales longer than the dominant tidal periods due to their persistence (Musgrave and Statscewich, 2006).

3.1.3.5. Bottom Friction Effects on Cook Inlet Currents

Measurements of currents in upper Cook Inlet have revealed that bottom friction influences the speed and alters the direction of tidal currents (USACE), 1993, 1996). Currents are slowed and veered several meters above the bottom. In this way, friction created by sloping inlet banks and shoals steer tidal currents. These trends are particularly notable when an acoustic Doppler current profiler measures currents. A bottom boundary layer, several meters thick, tends to reverse direction before surface tidal currents. High sediment concentrations near the bottom also affect the balance of frictional forces. Multi-beam hydrographic surveys of central Cook Inlet in 2000 revealed large sand dunes on the bottom with heights the order of 2 m (6.6 ft) (LGL Alaska Research Associates, Inc., 2000). These bedforms appear in constricted areas and in the vicinity of rip tides. Their presence is indirect evidence of vertical shear extended several meters above the bottom (LGL Alaska Research Associates, Inc., 2000).

3.1.3.6. Cook Inlet Rip Tides

Cook Inlet tide rips are zones of surface convergence and high horizontal velocity (Johnson, 2008). Cook Inlet rip tides are primarily driven by tides, because they follow the reverse direction pattern of rising and falling water levels. The speed with which rip tides move along the surface is proportional to the range of tidal heights. Cook Inlet experiences extreme tidal fluctuations of up to 12.2 m (40.0 ft) (NOAA, 1999) that often produce strong currents that are >8 kn (Tarbox and Thorne, 1996).

Surface circulation in upper Cook Inlet is driven by the mixing of incoming and outgoing tidewater combined with freshwater inputs. A southward flow along western lower Cook Inlet is due to the Coriolis force acting on freshwater entering the upper inlet from several large rivers. Convergence and divergence of different water masses (generally, southward-flowing low-salinity water and westward-intruding sea water from the ACC) create robust rip tides in Cook Inlet (LGL Alaska Research Associates, Inc., 2000). Semidiurnal tidal currents dominate circulation variability in Cook Inlet and establish strong frontal convergence zones known locally as the West Rip, Middle Rip, and East Rip (Okkonen, 2005).

Several rip tides consistently appeared in 1992 to 1999 satellite imagery along the longitudinal axis of the lower Cook Inlet (LGL Alaska Research Associates, Inc., 2000). The West Rip, Middle Rip, and East Rip are commonly observed east of Kalgin Island, extending south to Chinitna Bay (Shelden et al., 2014), and fishers have verified the persistence of these features, reporting that they often fish along them where salmon may concentrate (LGL Alaska Research Associates, Inc., 2000).

The West Rip forms approximately 3.7 km (2.3 mi) east of Kalgin Island and follows the island's east shoal along a 10 fathom (18 m, 59 ft) contour (LGL Alaska Research Associates, Inc., 2000). The West Rip can bend to the west across the shoal south of Ka1gin Island (LGL Alaska Research Associates, Inc., 2000).

The Middle Rip is the largest and deepest of the Cook Inlet rip tides, extending along a >40 fathom (73 m, 239 ft) channel through the center of the inlet (LGL Alaska Research Associates, Inc., 2000). The Middle Rip is as wide as 7.4 to 11.1 km (4.6 to 6.9 mi) and generally occurs between 13 and 22.2 km (8.1 and 13.8 mi) off the east coast of the inlet. It sometimes joins with the East Rip in the lower portion of the inlet. A flood tide can push the Middle Rip as far as 3.7 km (2.3 mi) to the west (LGL

Alaska Research Associates, Inc., 2000). The Middle Rip typically divides clear, relatively warmer incoming Gulf of Alaska water to the east, and silty, freshwater outflowing to the west.

The East Rip tends to align with a 10 fathom (18 m, 59 ft) contour along the east shore of the inlet. It can be as far offshore as 7.4 km (4.6 mi) and as close as 3.7 km (2.3 mi) off Cape Kasilof during a flood tide (LGL Alaska Research Associates, Inc., 2000).

In 2008, over 35,000 hours of data for Cook Inlet were delivered by drifters deployed between the Forelands and Cape Douglas (Johnson, 2008). The data document a high-energy, high-velocity, convergence zone to the east of Kalgin Island aligned in the north-south direction with the bathymetric slope (Johnson, 2008). This zone roughly corresponds to the location of the West Rip. Johnson (2008) showed that although circulation is dominated by tides, buoyancy- and wind-driven circulation play a critical role for particle trajectories and water transport in Cook Inlet.

Fishers in Cook Inlet also have reported that rip tides can materialize at almost any location in the central inlet, such as the Kalgin Island shoals, although rips tend to be observed over deep channels and follow bathymetric contours (LGL Alaska Research Associates, Inc., 2000). Rip tides may concentrate oil within or along their edges (LGL Alaska Research Associates, Inc., 2000). Oil within a rip tide can be difficult to collect as the fronts caused by the rip tide can submerge the oil after the oil has been boomed (LGL Alaska Research Associates, Inc., 2000).

3.1.3.7. Cook Inlet Sea Ice Conditions

In Cook Inlet, the amount of sea ice varies annually and is not prevalent across the entire proposed Lease Sale Area. Pack ice, shorefast ice, stamukhi (layered ice cakes formed by stacking of ice floes on shorefast ice over multiple high tides), and estuarine/river ice are all observed in Cook Inlet (Brower et al., 1988; LaBelle et al., 1983; Mulherin et al., 2001). Sea ice is most prevalent in the sale area during winter; sea ice generally begins to form in October or November, and increases through February, reaching its maximum extent in February from the West Foreland to Cape Douglas. It recedes as it melts in March to April. Other than localized freezing in protected bays during particularly cold periods, sea ice formation in Shelikof Strait is generally rare. Ice formation in upper Cook Inlet is driven by air temperature, while the air/water temperature and inflow rate of the ACC influence sea ice formation in the lower inlet (Shelden et al., 2014). Tidal action and tidal currents often shatter sea ice in Cook Inlet to the extent that there is seldom uniform cover. First year thin ice (approximately <70 cm (28 in)) with 80 to 100% coverage is historically found north of 60°30'N from December until late March, with lower concentrations in the southern inlet (Russel, 2000).

3.1.3.8. River Discharge

Freshwater input is important in determining the circulation within Cook Inlet (Okkonen, Pegau, and Saupe, 2009). Unfortunately, only a few rivers are gauged for measuring discharge, and those measurements cannot be made when a river is covered with ice (Okkonen, Pegau and Saupe, 2009). Discharge measurements on the Susitna River, the largest draining into upper Cook Inlet, shows a maximum discharge in May as the river first opens up (Okkonen, Pegau and Saupe, 2009). Through the summer there is considerable variability in discharge associated with rainfall within the drainage basin, but in general the flow decreases from June through August, and sometime in September it is dramatically reduced as snowmelt ceases and rainfall gives way to snow (Okkonen, Pegau, and Saupe, 2009). This is in stark contrast to the more southerly coastal areas, where freshwater input is at its maximum in September and October due to fall storms (Royer, 1982).

Mean annual volume of freshwater discharged by streams flowing into Cook Inlet exceeds 70 billion m^3 (16.794 mi^3) (see Lease Sale 191 (2003-055), Table III.A-1, from: Freethey and Scully, 1980); this volume is thought to be low because the discharge rates of several streams, particularly along the western side of Cook Inlet, have not been measured. Four major rivers (the Kenai, Knik, Matanuska and Susitna Rivers) drain into the Cook Inlet and constitute the largest riverine drainage into the Gulf of Alaska (Benke and Cushing, 2010; Brabets et al., 2009). Discharges from these rivers have large seasonal variability with high flows associated with snowmelt in the spring and storm events in the fall (Okkonen, Pegau, and Saupe, 2009). In general, discharge rates are low in November through March, begin to rise in April, peak in June, July, or August, and decline in September and October (see Lease Sale 191 (2003-055), Table III.A-1, from: Freethey and Scully, 1980). Many of the streams flowing into Cook Inlet are glacially fed and contain high concentrations of suspended particulate matter. An estimated 99% of the annual suspended particulate matter load is carried by the streams during the period from May through October (Parks and Madison, 1985). About 80 to 90% of the 63.5 million metric tons (70 million tons) of sediment deposited in lower Cook Inlet and Shelikof Strait is derived from suspended particulate matter in river flows, primarily from the Knik, Matanuska, and Susitna Rivers (Boehm, 2001; Feely and Massoth, 1982; Trefry, 2000).

3.1.4. Air Quality

3.1.4.1. Air Quality Regulation

The nation's air quality is regulated on a Federal level under the Clean Air Act (CAA), as amended (42 USC ch. 85, subch. I, §§ 7401 et seq.). The CAA requires the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS). The NAAQS set limits, or criteria, for ambient air concentrations of six "criteria" pollutants – SO_2, NO_2, CO, O_3, PM (PM_{10} and $PM_{2.5}$) and Pb (Title 40 CFR 50), which are considered harmful to public health and the environment at concentrations that exceed the NAAQS (EPA, 2015d). The NAAQS reflect the concentrations of criteria pollutants that reflect healthful outside (ambient) air. There are two types of NAAQS: primary standards to protect public health, including sensitive populations (e.g., asthmatics, children, and the elderly), and secondary standards to protect public welfare and "quality of life," including protection against degraded visibility and damage to animals, crops, vegetation, and buildings. The most recent revisions to the NAAQS were in 2013 and 2015, where EPA revised the upper limit for the primary annual standard for $PM_{2.5}$ to 12.0 micrograms per cubic meter (µg/m^3) (78 *Fed. Reg.* 3086, 1/15/2013) and revised the secondary O_3 standard to 0.070 ppm (80 *Fed. Reg.* 65292, 12/26/2015). Table 3.1.4-1 presents the current primary and secondary NAAQS for the six criteria pollutants.

Table 3.1.4-1. National Ambient Air Quality Standards (NAAQS).

Pollutant		Primary/ Secondary	Averaging Time	Level	Form of the Standard
Carbon Monoxide		Primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead		Primary and secondary	Rolling 3 month average	0.15 µg/m^3	Not to be exceeded
Nitrogen Dioxide		Primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and secondary	Annual	53 ppb	Annual Mean
Ozone		Primary and secondary	8-hour	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	Primary	Annual	12 µg/m^3	annual mean, averaged over 3 years
		Secondary	Annual	15 µg/m^3	annual mean, averaged over 3 years
		Primary and secondary	24-hour	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24-hour	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		Primary	1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Notes: Units of measure for the NAAQS are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (µg/m3).
Source: EPA (2015a).

Every State has jurisdiction for air pollutant prevention and control within its borders, and may establish their own AAQS through their State Implementation Plan (SIP), which must be approved by the EPA. However, the States' AAQS must be at least as stringent as the NAAQS, and a State may add additional pollutants and standards at their discretion when justified to the satisfaction of the EPA (42 U.S.C. 7410). Thus, States' AAQS would never be less stringent than the NAAQS, would include at a minimum all the currently applicable NAAQS, and a demonstration of compliance to the State AAQS would be sufficient for a presumption of compliance to the NAAQS.

Under the 2016 Alaska Administrative Code (AAC) (as amended), the State of Alaska Department of Environmental Conservation (ADEC) establishes its own AAQS and does not adopt the NAAQS by reference, and does not identify separate primary and secondary standards. Therefore, the standards established in the ACC are presumed to be primary. Alaska does not establish the EPA 2015 primary NAAQS of 0.070 as the 8-hour standard for ozone (18 ACC Sec. 50.010 (4)), and instead uses the EPA 2006 standard of 0.075. Thus, for regulatory purposes, the 2015 ozone NAAQS of 0.070 ppm must be applied to the Lease Sale alternatives for regulatory purposes. Further, Alaska regulates the following AAQS (ADEC, 2016a):

Annual standard for SO_x (sulfur oxides) (measured as SO_2) of 80 $\mu g/m^3$ (30 parts per billion (ppb)) where the standard cannot be exceeded; this was once a Federal standard but was revoked by the EPA (*see* Final Rule 75 *FR* 35520, June 22, 2010) (19 AAC Sec. 50.010(2)(A));

24-hour average standard for SO_x (measured as SO_2) of 365 $\mu g/m^3$ (139 ppb) where the standard cannot be exceeded more than once each year; this was once a Federal standard but was revoked by the EPA (*see* Final Rule 75 *FR* 35520, June 22, 2010) (18 AAC Sec. 50.010(2)(B));

30-minute standard for reduced sulfur compounds (expressed as SO_2) of 50 $\mu g/m^3$ (19 ppb) where the standard cannot be exceeded more than once each year (18 AAC Sec. 50.010(7)); and

8-hour standard for ammonia of 2.1 mg/m^3 where the standard cannot be exceeded more than once each year in the form of the average over any consecutive eight hours (18 AAC Sec. 50.010(8)).

The air quality agency of each coastal State has regulatory authority that extends from its "normal baseline" outward to the sea, lakes, and bays, up to 12 nautical miles (nm) (UN, 1982). The seaward extent of this ribbon of water along a coast is known as the State Seaward Boundary (SSB) (Presidential Proclamation No. 5928, 1988). The SSB for all coastal areas of Alaska is defined at three nm from the baseline (5 ACC 09.301). States maintain jurisdiction to control air pollution from OCS sources located within 25 nm of the SSB (CAA Sec. 328(a) and 43 U.S.C. 7627), which for Alaska extends to a point 28 nm seaward from the baseline. Within this area of water, the State of Alaska must attain and maintain Federal and State ambient air quality standards and comply with the provisions of Sec. 328 of the Clean Air Act (CAA) (42 U.S.C.7627). Further, such requirements must be the same as would be applicable if the source were located in the corresponding onshore area (COA) (40 CFR 55.2), and must include State and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and reporting.

The State of Alaska regulates air quality over the land area surrounding the waters of the Cook Inlet relative to a demarcated geographical area designated by EPA as the Cook Inlet Intrastate Air Quality Control Region (AQCR), where AQCRs are defined under 42 U.S.C. 7407 (40 CFR 81.54 and ADEC 18 ACC 50.020 Table 2). The Cook Inlet AQCR includes all of the Greater Anchorage Area Borough, the Kenai Peninsula Borough, and the Matanuska-Susitna Borough. Thus, the EPA regulations applicable to the COA refer to the attainment status of the Cook Inlet AQCR and are also relevant to the proposed Lease Sale Area; attainment status, which is characterized as either attainment, nonattainment, or unclassified, is defined in Sec. 107 of the CAA (42 U.S.C. 7407). Classifications (severity) of nonattainment areas are defined in Sec. 181 and Sec. 186 of the CAA

(42 U.S.C. 7511 and 7512, and are available on the EPA Green Book Website at https://www3.epa.gov/airquality/greenbook/define.html).

The U.S. Congress further categorizes attainment areas according to class areas – Class I, Class II, and Class III Areas – in the CAA Amendments of 1977 (NPS, 2004). There is a Federal Class I area in Alaska adjacent to the Cook Inlet, as shown in Figure 3.1.4-1 (40 CFR 81.402).

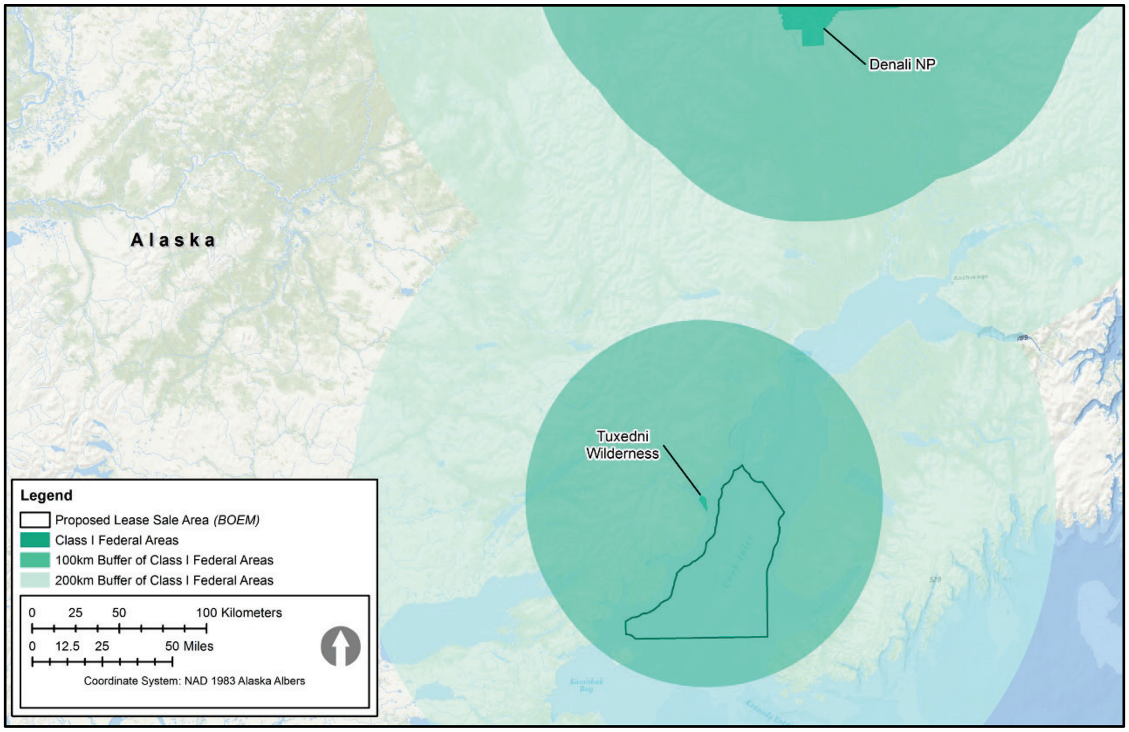


Figure 3.1.4-1. Tuxedni Wilderness Area PSD Class I Federal Area.

The Tuxedni Wilderness Area is a 2,252-hectare (ha)/(5,564.8-acre) area located on Chisik Island and Duck Island in the Cook Inlet, adjacent to the proposed Lease Sale Area (40 CFR 81.402). This area is relevant to this EIS because air quality in the Tuxedni Wilderness Area could be affected by future activities occurring within the proposed Lease Sale Area. The applicable standards of the PSD program are presented in Table 3.1.4-2.

Table 3.1.4-2. Prevention of Significant Deterioration (PSD)

Pollutant		Averaging Period	Class I	Class II	Class III
Nitrogen Dioxide		Annual	2.5	25	50
Particle Pollution	PM_{10}	Annual	4	17	34
		24-hour	8	30	60
	$PM_{2.5}$	Annual	1	4	8
		24-hour	2	9	18
Sulfur Dioxide		Annual	2	20	40
		24-hour	5	91	182
		3-hour	25	512	700

Notes: Increments (µg/m^3).

As the proposed Lease Sale Area is wholly contained within the 28-nm jurisdictional boundary of the shores of the Cook Inlet, the ADEC is required to apply EPA's OCS air quality regulations given under 40 CFR 55, including requirements for permitting emissions due to operations proposed under the proposed Lease Sale Area alternatives. Depending on the alternative, or future proposed exploration or development plan, the ADEC may require a Federal or State operating permit under title V of the CAA (40 CFR 70-71 and 42 U.S.C. 7661). In addition, compliance with the rules and standards under the EPA Prevention of Significant Deterioration (PSD) permitting program may be required to account for impacts to the Class I Tuxedni Wilderness Area, including possible requirements for Best Available Control Technology (BACT) to control and reduce emissions from OCS sources (42 U.S.C. 7479 (3)).

3.1.4.2. Air Quality Status

Within the Cook Inlet AQCR, a portion of the Anchorage urban area located 100 miles (mi)/160.9 kilometers (km) northwest of the proposed Lease Sale Area is designated a serious maintenance area for emissions of carbon monoxide. In addition, 1.5 mi/2.4 km northeast of Anchorage, the community of Eagle River is a moderate maintenance area for emissions of PM_{10}.(EPA, 2015a and 2016; ADEC, 2016d). No other nonattainment area or maintenance area for any other criteria pollutant is located within the Cook Inlet AQCR. The air quality analysis of potential emissions from future sources within the proposed Lease Sale Area must consider the impacts to these maintenance areas. Any other nonattainment areas in Alaska are too far removed from the location of the proposed Lease Sale Area to experience impacts.

3.1.5. Water Quality

The quality of water in the Cook Inlet OCS meets criteria for the protection of marine life according to Section 403 of the Clean Water Act (CWA), and no waterbodies within the proposed Lease Sale Area are identified as impaired per CWA, Section 303 by the State of Alaska (ADEC, 2013). Another measure of water quality, the federally mandated water quality standards adopted by the State of Alaska regarding toxic substances, including human health criteria and aquatic life criteria, are specified at 40 CFR 131.36. The Alaskan water quality regulations are within 18 AAC 70.

As described in further detail in Section 3.1.5.2, hydrocarbon concentrations in Cook Inlet sediments are comparable to values reported for background hydrocarbons in Alaska offshore coastal waters. Oil and gas production in Upper Cook Inlet therefore does not appear to be a source of petroleum contaminants (Boehm et al., 2001; Howell et al., 1998).

Additional information regarding water quality in Cook Inlet and discharge criteria is contained in the following EPA documents:

- Final Ocean Discharge Criteria Evaluation for the Cook Inlet Exploration NPDES General Permit AK215800 (EPA, 2013a)
- Water-Quality Assessment of the Cook Inlet Basin Alaska Summary of Data through 1997 (Glass, 1999)
- Final Ocean Discharge Criteria Evaluation General Permit AKG-31-5100 – Mobile Oil and Gas Exploration Facilities in State Waters in Cook Inlet (ADEC, 2014)
- Authorization To Discharge Under The National Pollutant Discharge Elimination System (NPDES) For Oil And Gas Exploration Facilities In Federal Waters Of Cook Inlet AKG-28-5100 (EPA, 2015a)
- Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (VGP) Authorization to Discharge under the National Pollutant Discharge Elimination System (EPA, 2013b)

3.1.5.1. Cook Inlet Watershed

The Cook Inlet Basin covers 101,851 km^2 (39,325 mi^2), and terrestrial altitudes range from 0 m (0 ft) above the National Geodetic Vertical Datum of 1929 to Denali, which rises to 6,190 m (20,310 ft). The Knik, Matanuska, Susitna, and Beluga Rivers are the major rivers draining into upper Cook Inlet

(Feely et al., 1980; Saupe, Gendron, and Dasher, 2005). Freshwater inputs include glacial meltwaters and stream flow. Mean annual volume of freshwater discharged by streams flowing into Cook Inlet exceeds 70 billion m^3 (91.557 billion yd^3) (Freethey and Scully, 1980). Discharge is usually comparatively large in streams receiving glacial meltwaters, because in the relatively dry summers of the Cook Inlet area, the flux of glacial meltwaters is highest (Brabets and Whitman, 2004). Because much of the water in this drainage basin originates in headwaters from melting snow and glaciers, sources of relatively pure water, much of the drainage basin's water is comparatively free of anthropogenic contaminants. However, although relatively pristine snowmelt runoff dominates the hydrology of streams in Cook Inlet Basin (Brabets and Whitman, 2004), melt also introduces large quantities of suspended sediment to streams. The Kenai, Kasilof, Ninilchik, and Anchor Rivers drain into Cook Inlet, transporting large quantities of glacial flour (Segar, 1995). Streams whose drainage areas are covered by as little as 5% glaciated terrain have distinct characteristics compared to those lacking glaciated drainage areas (Glass, 1999).

Deeper Gulf of Alaska waters flowing through the Kennedy and Stevenson Entrances supply nutrients to surface waters of Lower Cook Inlet (Saupe, Gendron, and Dasher, 2005). As those authors noted, the area sustains high production rates even in late summer (Larrance et al., 1977) and has some of the most productive high-latitude shelf waters in the world (Sambrotto and Lorenzen, 1987). Although upper Cook Inlet was not considered to be as productive as lower Cook Inlet, transport of terrigenous and saltmarsh carbon may support a more vigorous food web than previously thought (Houghton et al., 2005).

Based on standard salt balance calculations, 90% of waterborne contaminants will be flushed from the Cook Inlet in 10 months (Kinney, Button and Schell, 1969; Kinney et al., 1970). Because tidal turbulence is the major mixing process in this estuary, rather than seasonally varying freshwater input, the flushing rate is relatively invariant over the course of the year. However, persistent contaminants could accumulate in the food chain or in seafloor sediments (Brabets and Whitman, 2004). Given bioaccumulation and biomagnification, contaminants entering a food web have the potential to concentrate in predators near the top of the food chain. However, given the relatively rapid flushing of the Cook Inlet, and the vigorous tidal currents and winds in this region, pollutants entering the system may be rapidly diluted and dispersed.

Most of Cook Inlet Basin is undeveloped, with approximately 1% of the basins' area considered urban. However, the Cook Inlet watershed includes the largest urban area in Alaska, Anchorage, with a population comprising approximately two-thirds the total Alaskan population. As such, potential for pollution run-off is greatest in that portion of the watershed (Saupe, Gendron, and Dasher, 2005). Potential anthropogenic contaminants have been linked most strongly to urban expansion, but also may be tied to agriculture, logging, mining, construction, oil and gas exploration and development, recreational activities, and atmospheric deposition (Apeti and Hartwell, 2015; Glass et al., 2004). Dasher (2014) noted that municipal discharges are principally directed into marine waters, that there are limited industrial wastewater discharges in the area, and that the only large-scale mining operations are for coal.

3.1.5.2. Water Quality in Cook Inlet

Water quality in southcentral Alaska was evaluated during a study using the EPA's Environmental Monitoring and Assessment Program (EMAP) design and standardized protocols (Saupe, Gendron, and Dasher, 2005). Data were collected at 55 southcentral Alaska sites, including approximately 20 locations in Cook Inlet. A wide variety of parameters were assessed, including hydrographic properties, dissolved oxygen, nutrients, chlorophyll, suspended sediment, trace metals, and hydrocarbon components. All samples met Alaska Water Quality Standards (AWQS) criteria for dissolved oxygen and none of the waters in the Cook Inlet were oxygen depleted. Additionally, all samples from the study area met AWQS criteria for all marine water uses. These include aquaculture, growth and propagation of fish, shellfish, and other aquatic life and wildlife, and harvesting mollusks or other raw aquatic life.

Nutrients

Nutrient concentrations were consistently below NOAA threshold values (Saupe, Gendron, and Dasher, 2005). All dissolved inorganic nitrogen values were less than the NOAA threshold (1.0 milligram per liter (mg/L)). All surface samples had phosphate concentrations that fell well below the NOAA threshold value of 0.1 mg/L. The maximum phosphate value at the surface (30.5 microgram per liter (µg/L)) was measured at site AK02-0016, on the east side of Cook Inlet. Almost all samples (96.2%) had phosphate concentrations at the bottom of the water column that were below the NOAA threshold value. Sites that had the highest molar dissolved inorganic nitrogen, especially relative to dissolved inorganic phosphate, were in Upper and middle Cook Inlet, possibly reflecting reduced primary production rates due to the high suspended sediment loads (Saupe, Gendron, and Dasher, 2005). At the bottom across all sites, the nitrogen to phosphorous ratios were much closer to 16:1.

Stream Load and Suspended Sediment

Stream load, or the amount of solid matter carried by a stream, was measured during the USGS National Water-Quality Assessment (NAWQA) Program. Estimates of the concentrations of discharged suspended sediment were made at several rivers draining the Cook Basin (Brabets and Whitman, 2004). At two Kenai River sites, suspended sediment discharge varied by a factor of approximately 7 (129,000 tons/yr at a Soldotna site; 18,000 tons/yr at a Sterling site). Estimates of suspended sediment load were 3,700 tons/year for the Ninilchik River and 22,300 tons/year for the Deshka River. In both streams, most sediment was transported in spring. Estimates of suspended sediment discharges from urbanized streams were 215 tons/yr at South Fork/Campbell Creek (almost 80% occurring in the summer), and 420 tons/yr from Chester Creek, 43% in the spring. Together, the Knik, Matanuska, and Susitna Rivers contribute over 115,000 kg of suspended sediment daily to Upper Cook Inlet (Saupe, Gendron, and Dasher, 2005). Highest suspended sediment fluxes occur in summer as glaciers recede. Concentrations of total suspended solids in Cook Inlet are higher in the northern, more stream-influenced, end of the inlet and decrease through the lower Cook Inlet based on riverine input (Feely and Massoth, 1982; Saupe, Gendron, and Dasher, 2005; Segar, 1995). In the upper Cook Inlet, suspended sediment concentrations are typically high, and can reach 2,000 ppm (Saupe, Gendron, and Dasher, 2005), while measurements of light transmittance yield values <10% (Saupe, Gendron, and Dasher, 2005; Segar, 1995). In the Lower Cook Inlet, suspended sediment concentrations are more typically <100 ppm (Saupe, Gendron, and Dasher, 2005; Segar, 1995), with light transmittance values approaching 100% (Segar, 1995).

Sedimentary Trace Metals

Previous studies have found no evidence of heavy metal pollution in lower Cook Inlet, but some evidence for elevated mercury (Hg) in water and sediment, especially in the upper Cook Inlet, perhaps introduced by runoff (Segar, 1995). In general, the Saupe, Gendron, and Dasher (2005) study echoed these findings. That work also found significant correlations in sediment samples among the group chromium (Cr), copper (Cu), tin (Sn), and zinc (Zn), and noted that nickel (Ni) also correlated with Cr. Each of these also correlated with percent of fine-grained sediment, which might indicate a source in the finer-grained glacial sediments deposited in much of the study area. Factor analysis indicated the sediments appear to be derived almost entirely of river-borne sediments.

Highest concentrations of Cr and Ni occurred at a single site in Cook Inlet (AK02-0005). The site was located in Chrome Bay on the south end of the Kenai Peninsula in an area of ore production. During World War I, mining removed >2000 metric tons of chromite ore, enriched in both Ni and Cr; ore was shipped out between 1916 and 1918 (Gill, 1922, as cited in Saupe, Gendron, and Dasher, 2005). Natural erosion of the source ore or tailings in the nearshore environment possibly introduced high levels of Cr and Ni. Saupe, Gendron, and Dasher (2005) noted that Chrome Bay and neighboring Port Chatham are popular subsistence species areas, and noted that watersheds on the southern Kenai Peninsula (Chrome Bay, Port Chatham, and Seldovia) contained very high concentrations of Cr and Ni relative to samples from the other watersheds.

Apeti and Hartwell (2015) completed a baseline assessment of heavy metals in Cook Inlet, investigating surficial sediments of Kachemak Bay, Port Graham Bay, and Homer Bay. The authors emphasized that concentrations of most metals in Kachemak Bay were below NOAA's sediment quality guidelines for sediment toxicity to benthic communities. However, concentrations of Ni in eastern mudflat samples of the bay were higher than effects range-medium sediment quality guidelines, while concentrations of arsenic (As) and Cu were above effect range-low guidelines in all areas. Concentrations of Hg were higher than reported in other studies of southern Alaskan sediment (see Table 2; Apeti and Hartwell, 2015). The authors noted that the watershed of Cook Inlet lies atop large coal deposits (citing Flores, Stricker, and Kinney, 2004), and that coal has been burned in the region, so that sedimentary Hg in Kachemak Bay may have both natural and anthropogenic sources.

Samples from the head of Port Graham Bay had elevated Cr concentrations compared to other Kachemak Bay samples, and statistically higher concentrations of cadmium (Cd), Hg, and selenium (Se), while concentrations of As, antimony (Sb), and Pb were about half those of Kachemak Bay sediment. While the authors attributed these variations to differences in local geology, they noted, "Given the well documented harmful biological consequences of Cd, Cr, Hg, and Se, a follow-up study to assess bioavailability and bioaccumulation in local biota may be warranted…" (Apeti and Hartwell, 2015, p. 8).

Apeti and Hartwell (2015) further reported results of a USACE study of dredged sediment in Homer Bay (USACE, 2007), demonstrating concentrations of As and Cr that exceeded ADEC bench standards for soil (ADEC, 2008). The authors also noted that Saupe, Gendron, and Dasher (2005) reported concentrations for As and Cr similar to their findings. Saupe, Gendron, and Dasher (2005) and Apeti and Hartwell (2015) emphasized that the ability of a sediment to sequester contaminants increases with organic matter content and decreases with larger grain size, and thus fine-grained sediments (muds) with higher organic matter content and larger surface to volume ratios have a higher capacity to concentrate trace metals than do sands. To some extent then, the fine-grained character of muds in Homer Harbor may reflect natural sediment dynamics; however, the authors also observed this is a center of vessel activity and maintenance, so anthropogenic input of these metals may occur. They further remarked that the deep-water anchorage in Kachemak Bay is under consideration as a repair and safe refuge site for distressed and disabled vessels (ADEC, 2008), increasing the possibility of anthropogenic contamination there.

Hydrocarbon Constituents

Natural sources introducing hydrocarbons to southcentral Alaska's coastal ecosystems include oil seeps, eroded petroleum source sedimentary rocks, coal, terrestrial and marine plants and animals, peat, and the deposition of forest fire particulates (Saupe, Gendron, and Dasher, 2005). Anthropogenic sources of hydrocarbons to the area include discharges from the petroleum industry in Cook Inlet and Prince William Sound through the NPDES permitting program, municipal wastewater treatment discharges, non-point source runoff from urban areas, small spills from marinas and boats, as well as large spills such as the 1989 Exxon Valdez Oil Spill in Prince William Sound (Saupe, Gendron, and Dasher, 2005).

In an Upper Cook Inlet study done for Marathon Oil Company, only 1 of 26 water samples in the mixing zone contained a volatile organic analyte compound at a concentration greater than method I detection limits (2.9 μg/L toluene), and this sample was collected 50 m (164 ft) south of the Trading Bay treated water outfall (Neff and Douglas, 1994). Segar (1995, p. 5) cited Kaplan and Venkatesan

(1985), and noted "the entire area is uniformly free of petroleum contaminants, except in a few isolated cases."

Boehm et al. (2001) collected sediment samples in the outer portion of the Cook Inlet (Shelikof Strait) and found that the concentration of hydrocarbons has not increased appreciably since the introduction of oil exploration in Cook Inlet. Those authors also observed concentrations were comparable to values reported for background hydrocarbons in other studies from offshore coastal waters of Alaska; they concluded that there did not appear to be any identifiable enrichment of petroleum contaminants from anthropogenic activities, including oil and gas production in upper Cook Inlet (see also Howell et al., 1998, and references therein).

However, Wetzel (2010) showed PAHs were present in the upper Cook Inlet, although concentrations were almost an order of magnitude less than typically observed in urban areas. In Saupe, Gendron, and Dasher's (2005) study, site AK020003 in Chinitna Bay on the west side of Cook Inlet had the highest polycyclic aromatic hydrocarbon (PAH) concentration measured. This site was not inferred to be a depositional area for glacial fines that are associated with most depositional areas from upper Cook Inlet, so the authors concluded it was unlikely that the PAHs reflect the downstream transport of dissolved or particulate oil from upper Cook Inlet, either from oil industry operations or from the urban run-off or discharges near Anchorage. They suggested the PAHs were introduced by natural oil seeps that have been documented within the Chinitna Bay watershed (and in several other locations on the west side of Cook Inlet (Becker and Manen, 1988).

For all stations sampled in the southcentral Alaska EMAP study area, total PAHs were dominated by low molecular weight compounds and thus do not reflect an "urban background." The ubiquitous signature is similar for all of these sites reflecting a mixed source of hydrocarbons, dominated by low molecular weight PAHs, but including some high molecular weight compounds. The authors interpreted these data to indicate potential contributions to the PAH pool from coal, pyrogenic sources, petrogenic sources, and biogenic sources. Saupe, Gendron, and Dasher (2005) noted that Short et al.'s (2004) work suggests that a stable naphthalene component means the complex is not weathering in transit and likely is enclosed within a stable matrix such as particulates of oil shale so that PAHs do not appear to be bioavailable.

The Beluga Whale Study

Saupe et al. (2014) evaluated contaminants related to petroleum in the prey of Cook Inlet's beluga whale population. The Saupe et al. (2014) study assessed PAHs in belugas in Cook Inlet, because that population has been declining, and reasons for the decline are not understood. These belugas have the lowest levels of polychlorinated biphenyls (PCBs) and chlorinated pesticides, and concentrations of heavy metals of all other groups investigated (Becker et al., 2000). Previous work measured PAHs in archived beluga whale tissues (Reynolds, 2010; Wetzel, 2010), and found evidence that belugas in Cook Inlet are bioaccumulating PAHs from their environment or prey (Saupe et al., 2014). Fish that are known to serve as beluga prey were collected in the winter, and their tissues analyzed. No whole fish analyses demonstrated detectable levels of PAHs. Belugas may have been exposed to PAHs following exposure to "a pulse of hydrocarbons," or it may be that their prey consists of polychaetes as well as fish, since polychaetes lack the P4501A enzyme system that enables elimination of PAH molecules (Saupe et al., 2014).

Persistent Organic Compounds

Saupe, Gendron, and Dasher (2005) assessed samples for a suite of persistent organic pollutants, including most of "the dirty dozen" persistent organic pollutants, and a suite of 21 PCB congeners, as well as dichloro-diphenyl-trichloroethanes (DDTs) (total and 7 congeners), Cyclopentadienes (three pesticides), Chlordanes (four compounds), and 6 additional herbicides and pesticides. None of these were detected in any sediment sample, so that sample concentrations across the entire study area fell below any guidance levels.

Toxicity Studies

Saupe, Gendron, and Dasher (2005) used the 10-day Ampelisca amphipod survival test to explore sediment toxicity. For samples in Cook Inlet, only one station (AK02-0005) had amphipod survival rates less than 80%. As discussed above, site AK02-0005 had order of magnitude higher Cr and Ni values in sediments than any other station, and high concentrations of these metals are known to have detrimental effects on benthic community assemblages. Interestingly, site AK02-0005 had abundance, richness, and diversity indices that were in mid-range. This site was one of only two where oligochaetes, often considered to be able to tolerate stressful environmental conditions better than many other annelids, were identified.

The two sites with the lowest benthic invertebrate abundance, richness, and diversity were sites AK02-0011 and AK02-0012, the two northernmost sites in the Upper Cook Inlet. These sites had the highest total suspended sediment loads measured in the study area and some of the lowest total organic carbon (TOC) values (e.g., AK02-0012 had 0% TOC).

The only other site where oligochaetes were identified was site AK02-0003, the site with the second lowest total organic carbon, but highest concentration of PAHs found in the study area. Although these concentrations were well below the effect range-low value, oligochaetes are known to colonize oiled sediments at high densities. Site AK020003, located in Chinitna Bay, may have been impacted by petroleum seeps and where sediments are introduced by the Chinitna River.

3.1.5.3. National Water-Quality Assessment (NAWQA) Research

A body of water quality research was conducted in the Cook Inlet Basin under the auspices of the USGS NAWQA Program (Brabets and Whitman, 2004; Frenzel, 2000; 2002; Frenzel and Dorova, 1999; Glass and Frenzel, 2001; Glass et al., 2004). The NAWQA Program involves sampling streams, streambed sediment, and stream biota, while developing information about algal, macroinvertebrates, and fish communities, to characterize U.S. stream habitats. Data for the NAWQA Unit in the Cook Inlet Basin were developed between October 1998 and September 2001, with pilot work completed in 1997 (Frenzel and Dorova, 1999).

NAWQA reports have shown that water quality in the Cook Inlet Basin is affected by both natural forces and human activities (Glass et al., 2004). Glass et al. (2004, p. 1) summarized findings, "Water quality is generally good in Cook Inlet Basin, supporting most beneficial uses of water most of the time, including drinking, recreation, and protection of fish, other aquatic life, and wildlife."

However, there are areas of concern. Notably, streambed sediments in regions that drain undeveloped terrains sometimes demonstrated concentrations of one or more trace elements, notably Hg, As, Cr, Ni, and/or Zn, which exceeded guidelines for the protection of sediment-dwelling organisms. These elevated trace metal concentrations have been interpreted predominantly to reflect the geology of drainage areas within the Cook Inlet Basin (Apeti and Hartwell, 2015; Glass et al. 2004).

Additionally, samples from groundwater, lakes, streams, and streambeds in or near urbanized areas of Anchorage displayed a variety of contaminants whose concentrations exceeded one or more guidelines for ecosystem health. But of all water quality constituents sampled, none exceeded drinking-water standards, and only one exceeded aquatic-life standards (the pesticide carbaryl in some Chester Creek samples). Aquatic communities in these developed and urbanizing watersheds (e.g., Chester Creek) showed increased degradation, decreased diversity and abundance, and increased dominance of organisms that are more tolerant of physical and chemical disturbances (Brabets and Whitman, 2004; Glass et al. 2004). One of the primary issues then is how increasing urbanization and resource development will impact water quality and supply, and how changes to overall water quality in the Cook Inlet Basin might affect salmon, resident fish, and other aquatic life (Glass et al., 2004). Additionally, any dissolved pollutants, and possibly fine-grained sedimentary pollutants, introduced to streams through human activities eventually might be transported to the Cook Inlet, with the potential for reducing water quality there.

3.1.5.4. Climate Change and Water Quality

Climate change is affecting the sources and constituents of marine water as increasing carbon dioxide and increasing air temperatures force changes in seawater acidification, seawater temperature, and related water quality variables. Given the warming trends accompanying climate change (Section 3.1.1), glacial retreat and reduced runoff to Cook Inlet are anticipated (Glass et al., 2004).

3.1.5.5. Summary

The water quality of lower Cook Inlet generally is good. Turbulence, associated mainly with tidal currents, and winds, result in strong vertical mixing. Water with a large variety of naturally occurring inorganic and organic compounds is transported into Cook Inlet by streams and rivers, and by currents from the Gulf of Alaska. These substances, suspended or dissolved in the water column, are rapidly dispersed by tidal currents and winds. While contaminants have been reported, many are attributed to erosion of the local soils, rocks, and ores and few can be unambiguously linked to human activities. However, anthropogenic input of pollutants at urban centers has deleteriously impacted local streams and lakes (e.g. Chester Creek; Brabets and Whitman, 2004; Glass et al. 2004).

3.1.6. Acoustic Environments

Natural and anthropogenic activities contribute sound to the ocean, creating a complex acoustic environment. Acoustic environments generally can be described based on the sound sources and propagation characteristics. However, the acoustic environment is not merely an additive list of sound sources but instead refers to the spatial and temporal characteristics of acoustic energy within the physical environment and how the biological communities interact within the resultant habitat conditions. Assessing effects to the acoustic environment requires determining the noise conditions through which discrete signals must be sent and gathered by acoustically-adapted animals. Primary acoustic habitat for most species is focused within the vocal ranges for that species; therefore, the same noise conditions may impact the acoustic environment for one species but not another.

3.1.6.1. Major Contributing Noise Sources in the Ocean

Natural Sources

The dominant physical mechanisms producing naturally occurring sound in the ocean are wind and wave activity at or near the ocean surface. Sound levels associated with wind and waves are generally correlated with one another and contribute energy in the 1 to 30 kHz frequency band. Ambient noise levels tend to increase with increasing wind speed and wave height (Richardson et al., 1995; Urick, 1984). Precipitation on the ocean surface also contributes sound to the ocean. In general, noise from rain or hail is an important regional component of total noise at frequencies >500 Hz during periods of precipitation. Rain can increase natural ambient noise levels by up to 35 dB across a broad band of frequencies from several hundred Hz to >20 kHz (National Research Council (NRC), 2003a; Richardson et al., 1995). Heavy precipitation associated with large storms can generate noise at frequencies as low as 100 Hz and significantly affect ambient noise levels at a considerable distance from a storm‘s center (U.S Department of Homeland Security, U.S. Department of the Navy, 2001).

Geological noise from earthquake, volcanic, and hydrothermal vent activity can contribute greatly to ambient noise at low frequencies, particularly in geologically active areas. Movement of sediment across the seafloor by currents also can be a primary contributor to ambient noise at frequencies from 1 to >200 kHz in some environments (NRC, 2003a).

Sea ice noise levels are highly variable and seasonal but can be a significant contributor at high latitudes. Sea ice noise and some biological signals (namely, from ice-adapted seals) are strongly correlated (Moore et al., 2012). The acoustic impact of ice cover varies according to the type of ice cover, whether it is shore-fast pack ice, ice floes and moving pack ice, or ice at the marginal ice zone, and the areal extent of ice (NRC, 2003a).

Biological noise, sounds created by animals, can contribute significantly to the level of ambient noise in certain areas of the ocean. Marine mammals are major contributors to the level of ambient noise in certain areas of the ocean, but some crustaceans (e.g., snapping shrimp) and soniferous fish also can generate noise that effectively changes the dominant characteristics of an acoustic environment (NRC, 2003a; Richardson et al., 1995).

Anthropogenic Sources

Shipping noise is the main contributor to ambient ocean noise in the low-frequency band (Hildebrand, 2009; NRC, 2003a). Noise in the low-frequency band has a broad maximum around 10 to 80 Hz, with a steep negative slope at >80 Hz. According to ambient noise spectra presented by Hildebrand (2009), spectrum levels of ambient noise from shipping are 60 to 80 decibels re 1 squared microPascal per Hertz (dB re 1 μPa^2 Hz^{-1}). In the open water, ship traffic can influence ambient background noise at distances of thousands of kilometers; however, the effects of ship traffic sounds in shallow coastal waters do not reach that far, most likely because a large portion of the sound's intensity is absorbed by soft, nonreflective, unconsolidated materials (muds and sands) on the seafloor. Other anthropogenic sources include dredging, oil and gas operations, nearshore construction activities, recreational vessels, geophysical research operations, and military preparedness exercises (e.g., sonar signals).

3.1.6.2. Acoustic Environments within Cook Inlet

Natural Conditions

Cook Inlet is a high-energy, dynamic environment with large tides, strong currents, natural seismic activity, and seasonal sea ice cover (Moore *et al*., 2000), all of which contribute to a generally high noise environment when compared to open ocean habitats.

Anthropogenic Conditions

Cook Inlet includes several active ports and harbors, commercial and recreational fishing activities, an on-water tourism industry, and several sea-plane ports. In addition to overall high ambient noise conditions, these activities introduce man-made noise into the Cook Inlet environment directly through their operations, and indirectly through necessary support activities and maintenance, such as dredging and pile driving.

In 2001, underwater recordings were made from four sound sources within Cook Inlet: 1) overflights by commercial and military aircraft landing at or taking off from Anchorage International Airport (ANC) or Elmendorf Air Force Base (AFB); 2) an oil platform in northwest Cook Inlet; 3) large and small vessel traffic operating in the Anchorage Harbor; and 4) ambient sounds in areas removed from industrial activities (Blackwell and Greene, 2003). Study locations are shown in Figure 3.1.6-1, and results are summarized in Table 3.1.6-1. Ambient measurements showed broadband levels ranging from 95 to 120 dB re 1 µPa. While the levels varied broadly among sites, measurements at individual sites did not vary greatly. The two quietest areas also were the farthest from any industrial influence.

Table 3.1.6-1. August 2001 Sound Measurements from Cook Inlet.

Measurement Location	Broadband Sound Pressure Level (dB re 1 µPa) Underwater	Comment	Type of Measurement
Birchwood	95 dB	Mean value, lowest noise level recorded	Ambient, non-industrial
Mouth of Little Susitna River	100 dB	Mean value	Ambient, non-industrial
Anchorage International Airport	105 dB	Mean value	Ambient for over flight measurement location
Between Fire Island and Little Susitna River	113 dB	Mean value	Measurement, non-industrial
Anchorage Harbor	113 dB	Mean value	Ambient for harbor measurement
Eagle River, ambient	118 dB	Mean value	Ambient, non-industrial
Elmendorf AFB, ambient	119 dB	Mean values	Ambient for over flight measurement location
North of Point Possession, ambient	120 dB	Mean value	Ambient, non-industrial
Overflights, commercial aircraft taking off from Anchorage International Airport	110-124 dB	Range of values for 8 different aircraft	Overflight
Overflights, military jets (mainly F-15s) landing at Elmendorf Air Force Base	122-134 dB	Range of values for 2 military jets	Overflight
Phillips A oil platform	119 dB; 97 to 111 dB	Highest value recorded; range of means at distances of 0.3 to 19 km from platform	Platform
Tug Leo docking gravel barge Katie II	149 dB	Highest value, recorded at 102 m	Vessel
Avon rubber boat driving by at full speed	142 dB	Highest value, recorded at 8.5 m	Vessel
Emerald Bulker (cargo-bulk carrier), departing	134 dB	Highest value, recorded at 540 m	Vessel
Northern Lights (cargo-freight ship), docked	126 dB	Highest value, recorded at 114 m	Vessel

Note: Locations of Measurements are Shown in Figure 3.1.6-1.
Source: Blackwell and Greene, 2003

One ambient site north of Point Possession was far-removed from any industrial influence but had one of the highest broadband levels (Table 3.1.6-1). High ambient noise levels were attributed to the motions of bottom pebbles during the incoming tide. Cook Inlet has some of the most extreme tides in the world with regard to flow rate and volume. These extreme tidal currents can produce noise at frequencies of >10 Hz from at least three mechanisms (Urick, 1983): (1) noise from turbulent flow in the water; (2) noise from water flow over the bottom, especially if there are loose rocks that can move as bedload; and (3) noise from the surface, if the flow induces surface roughness. Therefore, it is likely that tidal influences in Cook Inlet are a predominant contributor of noise to the acoustic environment.

Shipping noise has been identified as a potentially major contributor to the acoustic environments of Alaska and the Arctic region (Huntington et al., 2015. Basin-scale modeling has not been conducted for Cook Inlet; however, evaluation of potential noise contribution from shipping can be inferred from vessel traffic density information. In a 2012 Cook Inlet Vessel Traffic Study Report (Cape International, Inc., 2012), patterns of activities were described for vessels >300 gross tons operating during 2010. Results showed that there were 480 port calls or transits through Cook Inlet, with 80% of the transits made by 15 ships for the purpose of crude oil and product transport; packaged commodity shipments; and passenger/vehicle carriage. This class of vessel is characterized by sources at 6 to 500 Hz with source levels of 160 to 200 dB re 1 µPa@1m within the dominant frequencies (McKenna et al., 2012; Richardson, 1995).

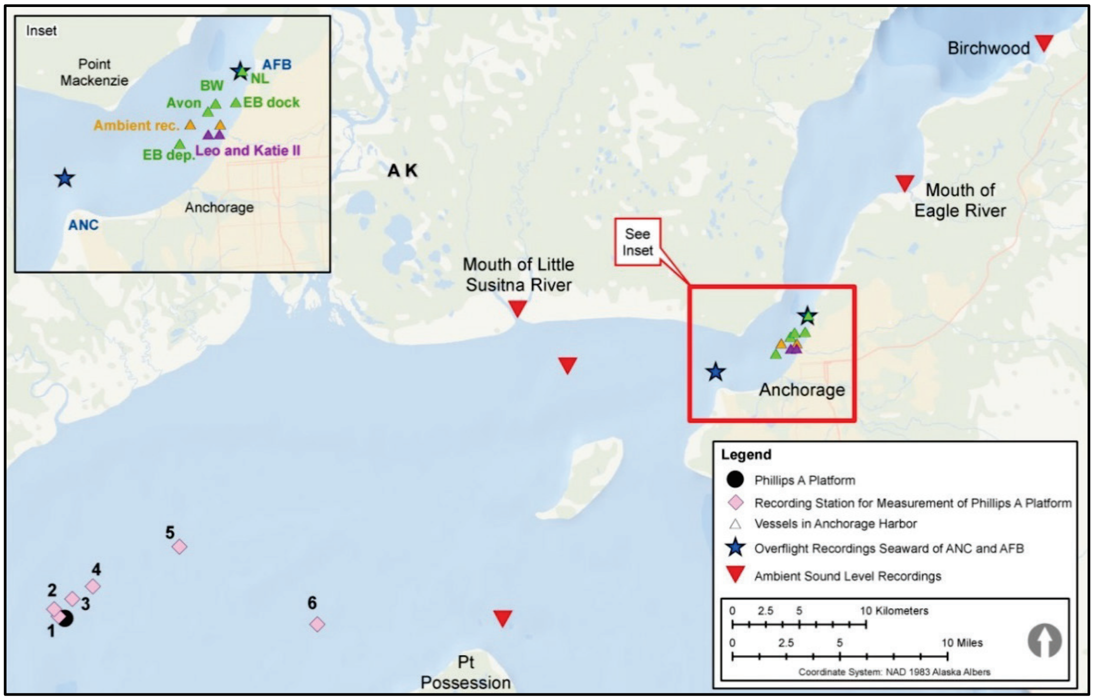


Figure 3.1.6-1. Locations of Sound Measurements Recorded in Cook Inlet during August 2001. *Source: Blackwell and Greene 2003.*

Vessel traffic can be used to infer how the acoustic environment will be affected by shipping noise. Although propagation modeling is the more accurate and comprehensive approach to assessing the impacts on the acoustic habitat; it is outside the scope of this document. Therefore, vessel activity patterns are used as a general proxy for shipping contribution of noise in the acoustic habitat. Activity patterns over one year show high levels of vessel traffic transiting through the Port of Kodiak, Port of Homer and Port of Anchorage, with offshore supply vessels (OSV), tug vessels, and tour boats representing 86%of the total underway operating days for vessels in Cook Inlet (Section 3.4.3). Ship traffic density maps show that most transits are made around the Port of Kodiak, and along the eastern margin of Cook Inlet between the southern end of the Kenai Peninsula and Anchorage (cf., Section 3.4.3; Figure 3.4.3-1).

The seasonal nature of activity in Cook Inlet and the inflow of ice into the region during winter likely decrease the contribution of ship noise during the winter months. Therefore, there is a seasonal intensity of anthropogenic noise during the summer months from all sources, particularly within the proposed Lease Sale Area. Ice interaction during extreme tidal fluctuations likely will produce high intensity, broadband sounds throughout Cook Inlet but only during specific winter conditions.

Aircraft can contribute to underwater sounds. In the previously cited study by Blackwell and Greene (2003; see Table 3.1.6-1), aircraft noise was measured at two locations immediately seaward of the runways from ANC and Elmendorf AFB. Underwater measurements at these locations showed maximum levels of 124 dB re 1 µPa for a departing DC-10 flying straight overhead from ANC and 134 dB re 1Pa for a landing military jet flying straight overhead with average measurements of 118.4 ± 5.7 dB re 1 µPa for the ANC site and 128.0 ± 9.0 dB re 1 µPa for the Elmendorf AFB site.

Oil and gas activities contribute to the acoustic environment of Cook Inlet. As of 2015, there were 17 oil and gas platforms established within Cook Inlet. Measurements of broadband sound pressure levels near the Phillips A Platform ranged from 97 to 111 dB re 1 µPa (Blackwell and Greene, 2003). Measurements were taken from 0.3 to 19 km (0.2 to 11.8 mi) from the platform indicating a wide area of propagation for these sound levels from a single platform. Drilling operations produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases (USDOI, MMS, 2000).

Position-keeping in Cook Inlet is likely a challenge due to the strong currents, and many platforms may be anchored rather than use dynamic positioning (DP); however, ships using dynamic positioning are used extensively in oil and gas operations, and marine construction operations, and often represent the loudest source of sound during operations. Modeled acoustic propagation (LGL and JASCO Research Ltd., 2005) assumed a four-thruster vessel at 100%operational power. This analysis resulted in one-third (1/3)-octave band source levels from 148.5 dB re 1 µPa @ 1 m at 2,000 Hz to 174.5 dB re 1 µPa @ 1 m at 10 Hz.

3.2. Biological Environment

This section describes biological resources of the Cook Inlet region, including lower trophic level organisms (planktonic and benthic communities), fish and shellfish, marine mammals, terrestrial mammals, birds, and coastal and estuarine habitats. Geographically, the discussion focuses on the proposed Lease Sale Area but includes all waters, seafloor habitats, shorelines, and coastal habitats of Cook Inlet and all areas potentially contacted by a large oil spill as explained in Appendix A. Where appropriate for individual resources, the discussion includes broader regional information (e.g., encompassing the Cook Inlet watershed, or the Gulf of Alaska) and/or global perspectives.

3.2.1. Lower Trophic Level Organisms

This section discusses the lower trophic level organisms found within Cook Inlet that could be affected by the proposed action alternatives. Lower trophic level organisms can be categorized as planktonic communities consisting of phytoplankton and zooplankton, and benthic communities consisting of infauna and epifauna. These communities (excluding microbial components) primarily are made up of invertebrates, and they occupy multiple habitat types from the intertidal zone to the open ocean. A few of the invertebrates are commercially important, including shrimp, crabs, and clams (see Section 3.3.2 for the discussion of Commercial Fishing). General descriptions of the invertebrate groups, and their ecological roles, and discussions of the marine benthic habitats, marine pelagic habitats, and invertebrates, and lower trophic levels in Cook Inlet are provided in USDOI, BOEM (2012b).

3.2.1.1. Plankton Communities

Phytoplankton

Pelagic waters within Cook Inlet are influenced by riverine and marine inputs resulting in salinity gradients and horizontal mixing throughout the inlet. The amount of sea ice within Cook Inlet varies annually, beginning to form in October or November and melting from March to April, although, in general, extensive areas of pack ice do not form within the inlet because of the large tidal range and strong tidal currents (see Section 3.1.3.7 for a more detailed discussion of ice). The upper Cook Inlet is strongly affected by sediment loading, which causes turbidity in that region of the inlet while the lower Cook Inlet is influenced by mixing of freshwater and marine water (Sambrotto and Lorenzen, 1987) and is an upwelling area (Abookire et al., 2000).

The pelagic habitat of Cook Inlet is highly productive with phytoplankton blooms peaking in the spring as the water column stratifies and light levels increase (Piatt, 2002). Tidal flux and strong winds resuspend nutrient-rich bottom sediments allowing productivity to remain high in the summer. Additionally, the western side of Cook Inlet generally has lower productivity due to a greater sediment input than occurs on the eastern side. Diatoms and microflagellates dominate the phytoplankton assemblage of Cook Inlet (Sambrotto and Lorenzen, 1987), and there is a transition in phytoplankton species from west to east across the inlet, as well as a seasonal succession of species (Piatt, 2002).

Sambrotto and Lorenzen (1987) estimated annual primary production of at least 300 grams of carbon per square meter (g C/m^2), peaking in the summer months within the lower Cook Inlet, and Balcom et al. (2011) estimated average annual net primary production of 8.97 million tons of carbon between 1998 and 2009. In 2014, the average concentration of chlorophyll *a* ranged between 0.48 and 42.57 mg m^{-3} in the proposed Lease Sale Area. Speckman et al. (2005) concluded that the abundance and distribution of phytoplankton, zooplankton, and forage fish in Cook Inlet were affected more by spatial variability in physical oceanography than by interannual variability, while Eslinger et al. (2001) concluded that the primary environmental influence on phytoplankton biomass appeared to be nutrient concentrations, while currents may also play a role.

Zooplankton

Coastal waters throughout the Gulf of Alaska, including Cook Inlet, contain similar zooplankton communities due to the influence of the ACC (Cooney, 1987; Piatt, 2002). Water masses from the ACC are drawn into the lower Cook Inlet via tidal fluxing resulting in water column invertebrates in the Cook Inlet that are composed of a mix of oceanic and coastal species (Piatt, 2002; Speckman et al., 2005), and dominated by several species of copepods (Cooney, 1987; Incze, Siefert, and Napp, 1997; Liu et al., 2008; Sturdevant, 2001), with significant contributions from other taxa such as cnidarians on the shelf, and euphausiids, pteropods and larvaceans seasonally in Prince William Sound (Neher et al., 2015).

Some of the highest standing stocks of zooplankton in the Gulf of Alaska are found in Cook Inlet with concentrations peaking in late spring and summer, and tracking seasonal peaks of phytoplankton (Piatt, 2002). Peak densities in excess of 1000 mg/m^3 are not unusual, while Piatt (1994) found that zooplankton were most abundant (~ 60 to 80 mg/m^3) on the northeast side of the entrance to Cook Inlet. Cooney (1987) showed that the zooplankton community in Kachemak Bay and the lower Cook Inlet are dominated by barnacle nauplii and crab zoea from April to August.

Additional studies indicate that densities of zooplankton and larval fish and eggs in the Shelikof Strait are higher than on the adjacent continental shelf. Variations in zooplankton and larval fish and egg densities, as well as phytoplankton productivity in the region, are influenced primarily by physical factors such as currents, salinity, and temperature (Bacheler et al., 2009; Incze, Siefert and Napp, 1997; Kendall, Schumacher, and Kim, 1996; Napp, Incze, and Ortner, 1996; Neher et al., 2015).

Eslinger et al. (2001) showed that the Cook Inlet, Shelikof Strait, and Prince William Sound area exhibits strong benthic-pelagic coupling, as springtime fluxes of phytoplankton to the seafloor are greatest during years when phytoplankton blooms in Prince William Sound are of short duration and have high biomass. Furthermore, soft sediment habitats of the area also contribute to water column productivity when sediments are resuspended by wind and wave action, introducing nutrients to the water column.

3.2.1.2. Benthic Communities

Benthic communities in the Cook Inlet are influenced by depth, substrate type, time of year, nutrient supply, and exposure to physical stressors (e.g. ice scour, salinity variations, waves, and sunlight). Several distinct benthic habitats have been identified based on ice formation, intertidal and subtidal inundation, and substrate type (e.g. rock, cobble, sand, silt, mud, and/or shell debris). Sediment grain size influences benthic species composition with suspension-feeding species inhabiting coarser sediments and deposit-feeding species inhabiting finer sediments (ADNR, 2009a; Foster et al., 2010; Mundy, 2005; Pentec Environmental, Inc., 2011).

The intertidal and subtidal habitats of Cook Inlet support infaunal and epifaunal invertebrates and the invertebrates within these communities are trophic links connecting primary producers to higher trophic level organisms; the latter are often of commercial importance and include shellfish, herring, crabs, salmon, rockfish, and cod.

Intertidal and Shallow Subtidal Communities

Lees et al. (1980) and Pentec Environmental, Inc. (2011) evaluated the intertidal and shallow subtidal communities in the lower Cook Inlet. Overall the studies concluded that the composition of benthic invertebrates on the western side of the inlet contains more Arctic species, while temperate species are more common on the eastern side, due to the seasonal ice scour. Intertidal and shallow subtidal communities in the ice-free eastern lower Cook Inlet are similar to those in the waters of southeastern Alaska, British Columbia, and Washington, while communities in the western lower Cook Inlet more closely resemble those in the Bering and Beaufort Seas (Lees et al., 1980; Pentec Environmental, Inc., 2011). Foster et al. (2010) reported similar results and indicated that the dominant benthic taxa on the west side of Cook Inlet, in decreasing order of abundance, were prosobranch gastropods (snails), bivalves, ascophoran and anascan bryozoans, and decapod crustaceans. In Kachemak Bay on the east side of lower Cook Inlet and in Prince William Sound, the prosobranch gastropods strongly dominated the fauna, followed by bivalves, but decapods (crabs) were also well represented.

Floral communities within the rocky intertidal and shallow subtidal zones were found to be dominated by multiple species of brown algae and mid-intertidal zones were dominated by a single genus (*Fucus* sp.) of green algae (Lees et al., 1980). Lower intertidal areas were dominated by kelp beds out to depths of approximately 20 m (66 ft) (Lees et al., 1980; NOAA, 1977). The east coast of Cook Inlet supports a more diverse and more productive algal assemblage than does the western coast; algal production declines sharply along both coasts moving north towards the upper inlet (NOAA, 1977).

Dominant invertebrate species within intertidal and shallow subtidal communities include herbivores (e.g., sea urchins, chitons, and limpets), suspension feeders (mussels, clams, polychaetes, bryozoans, and sponges) and predators/scavengers (e.g., sea stars, snails, and crabs) (Foster et al., 2010; Pentec Environmental Inc., 2011). More specifically, rocky habitats are dominated by epifaunal suspension feeders such as sponges, anemones, bryozoans, mussels, and barnacles; mobile species include crabs, chitons, snails, sea stars, and urchins. Sandy, silty, and muddy intertidal substrates are dominated by infaunal suspension- and deposit-feeders, particularly polychaete worms, gammarid amphipods, and clams (Mundy, 2005). Deeper sands are dominated by razor clams and muddy beaches are typically dominated by clams and echiurid worms. Substrates consisting of shell debris generally have the most diverse communities and are dominated by mollusks and bryozoans (Lees et al., 1980; Pentec Environmental, Inc., 2011; NOAA, 1977).

Deep Subtidal Communities

Nutrient supply decreases as distance from shore increases resulting in decreased benthic productivity in the deep subtidal area. Infaunal invertebrates within the deep subtidal benthic community primarily consist of mollusks, polychaetes, and bryozoans (Lees et al., 1980; Pentec Environmental, Inc., 2011). Subtidal infaunal organisms are important trophic links for crabs, flatfishes, and other common Cook Inlet organisms. Deposit-feeding species dominate areas with fine-grained sediment cover, while suspension-feeding species are more common in sandier areas.

Subtidal epifaunal organisms consist primarily of crustaceans (Tanner crab (*Chinoecetes bairdi*) and snow crab (*C. opilio*) king crabs, pandalid, and cragonid shrimp) and echinoderms (sea cucumbers and sea urchins) (Feder and Jewett, 1987; Lees et al., 1980; NOAA, 1977). Where kelp beds are present, there are well-developed components of sedentary and predatory/scavenger invertebrates. Where no kelp beds are present, e.g., the western Cook Inlet, there is a well-developed sedentary invertebrate component with a moderately developed predator/scavenger component (Feder and Jewett, 1987). Juvenile Tanner crabs are an important prey for commercial fish species including halibut, Pacific cod (*Gadus macrocephalus*), and great sculpin (*Myoxocephalus polycathocephalus*), and adult Tanner crabs are caught commercially. King crabs occur year-round in and around Kachemak and Kamishak Bays, with the rocky shallow outer portions of Kachemak Bay acting as nursery areas (Feder and Jewett, 1987; NOAA, 1977). Adult king crabs feed predominantly on pink neck clams, barnacles, and snails (Feder and Jewett, 1987). The southern portion of the lower Cook Inlet (including Kachemak Bay) also supports significant populations of pandalid shrimp (Feder and Jewett, 1987; NOAA, 1977). These shrimp feed mostly on polychaetes, crustaceans, and bivalve mollusks, and are in turn fed upon by Tanner crabs and bottom-feeding fishes.

The benthic habitat in deeper waters of Cook Inlet is characterized by unconsolidated sediments on a smooth bottom and strong tidal currents (Feder and Jewett, 1987; Foster et al., 2010). Benthic communities are represented by two major infaunal groups: deposit feeders characterize muddy substrata, and suspension feeders dominate sandy substrata.

3.2.2. Fish and Shellfish

3.2.2.1. Pelagic Fish

Pelagic fish usually inhabit water above the abyssal zone (waters >4,000 m (13,100 ft) deep), and beyond the nearshore littoral zone, between high- and low-water marks. Many of these finfish migrate long distances in response to changing environmental conditions for food or reproduction. Some pelagic fish segregate by life-history stage and use different habitats during these different stages.

Forage fish are a critical food source to multiple marine mammal, seabird, and larger fish species. Forage fish provide critical ecosystem functions by transferring energy from primary or secondary producers to higher trophic levels (Springer and Speckman, 1997). While abundance and distribution of these schooling fish vary, forage fish occur throughout Cook Inlet, with fish densities greatest during early summer.

Longfin Smelt (*Spirinchus thaleichthys*)

Unless cited otherwise, information in this subsection is from the ADFG (2015a). The longfin smelt (*Spirinchus thaleichthys*) is anadromous, spending part of its life in the ocean and part of its life in freshwater. In Alaska, longfin smelt are seasonally abundant in several drainage basins from southeast Alaska, north to Prince William Sound and Cook Inlet, and westward to Shelikof Strait in the Gulf of Alaska.

Longfin smelt gather in large schools off the mouths of freshwater spawning streams and rivers. They appear to use streams that have the best habitat conditions in the general area where they were spawned. Because stream temperature can affect the timing of spawning migration, numbers of spawning longfin smelt returning to a particular stream can vary greatly from year to year depending on stream water conditions, and overall ocean survival. In southeast Alaska, the main spawning migration can occur as early as April, while in southcentral Alaska, longfin smelt have been observed returning to the Kenai River in late November through early December. Some streams can have two separate but overlapping migrations of longfin smelt.

Longfin smelt are important food for birds and piscivorous fish. Juvenile longfin smelt feed on shrimplike crustacean, insect larvae, and other bottom-dwelling crustaceans, while adults at sea feed on small crustaceans such as copepods, cumaceans and euphausiids (Morrow, 1980).

Pacific Herring (*Clupea pallasi*)

Unless cited otherwise, information in this subsection is from ADFG (2015a). Pacific herring (*Clupea pallasi*) occur in large schools in the Cook Inlet in early April, and possibly through early fall. Herring are important prey for a wide variety of fishes, mammals, and birds. Pacific herring migrate in schools and are found along both shores of the North Pacific Ocean.

Pacific herring generally spawn during the spring. In Alaska, spawning first occurs in the southeastern archipelago during mid-March, in Prince William Sound in April and May, and in the

Bering Sea during May and June. Spawning is confined to shallow, vegetated areas in intertidal and subtidal zones. Young larvae drift and weakly swim with ocean currents and are preyed on extensively by other vertebrate and invertebrate fauna. Following metamorphosis of larvae to the juvenile form, fish rear in sheltered bays and inlets, and appear to remain segregated from adult populations until they mature.

In the Cook Inlet, herring usually first spawn in their second year and may continue to spawn annually for up to 15 years. Herring spawn extensively along much of the Shelikof coast of Kodiak Island, and the southern Alaska Peninsula, areas that might be affected by the Proposed Action. Kamishak Bay is a major spawning area that supports a short-season sac-roe fishery. Herring inhabit distinctly different habitat areas during different periods of the year. After spawning, most adults leave inshore waters and move seaward to feed primarily on zooplankton such as copepods and other crustaceans. They are seasonal feeders and accumulate fat reserves for periods of relative inactivity. Herring schools often demonstrate a diel vertical migration, spending daylight hours near the seafloor and moving upward during the evening to feed.

Pacific Sand Lance (*Ammodytes hexapterus*)

The Pacific sand lance (*Ammodytes hexapterus*) occurs throughout coastal marine waters of Alaska (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). Information reported in the following is from Robards et al. (1999).

Sand lance are abundant in shallow, nearshore areas ranging in depth to 100 m (328 ft), but they are most common at depths <50 m (165 ft), and often are found in water as shallow as 6 m (20 ft). This shallow distribution probably results from their preference for light, and the accessibility of prey.

Sand lance are a quintessential forage fish, and as a group are possibly the single most important taxon of forage fish in the Northern Hemisphere. Sand lance are preyed on by numerous species of seabird, marine mammal, and fish, in addition to various land birds and animals. Spawning occurs in late September and October on sandy beaches and fine gravel in the intertidal zone, soon after summer water temperature begins to decline. Larvae hatch before the spring plankton bloom.

Population fluctuations and distribution of predators frequently are linked to sand lance abundance. Sand lance also play an important role in the ecosystem as a consumer of zooplankton. Juvenile and adult sand lance exhibit the rather unusual habit of alternating between lying buried in the substrate and swimming in well-formed schools. They typically are associated with sandy and fine gravel substrates, up to and including the intertidal zone. Their use of substrates appears to be highly specific. In the natural environment, substrates used by sand lance have been characterized consistently as well washed, drained, and not packed, and typically contain coarse sands with little or no mud and silt. Sand lance also avoid oil-contaminated sediments. Although wide ranging, their preference for specific shallow substrates results in patchy group distribution. Sand lance bury themselves within the substrates during periods of low light, during estivation (i.e., passing hot periods in torpor), and during dormant periods, or occasionally in response to predators. Most investigators have reported that sand lance are abundant in preferred habitats from spring to late summer, and are uncommon during the remainder of the year.

Feeding occurs primarily in the water column, although epibenthic invertebrates occasionally appear in the diet. Feeding habits of sand lance change with age. Larvae feed on phytoplankton, diatoms, and dinoflagellates. However, once juveniles reach 10 mm (0.4 in), they feed on nauplii of copepods in summer, and euphausiids in winter. Adult fish prey on macrocopepods, chaetognatha, and fish larvae.

Eulachon/Candlefish/Hooligan (*Thaleichthys pacificus*)

Information in this subsection is from ADFG (2015a).

Eulachon are anadromous, spawning and hatching in freshwater. They grow to maturity in the ocean where, as juveniles and adults, they feed mainly on euphasids, a small shrimplike crustacean sometimes called krill. As the spawning season approaches, eulachon gather in large schools off the mouths of spawning streams and rivers. The upstream migration is keyed closely to the water temperature of the stream. In southeast Alaska, the migration can occur as early as April, while in central and western Alaska it generally takes place in May. Some streams have two separate but overlapping migrations. After spawning, most eulachon die. Eggs are broadcast over sandy gravel bottoms where they attach to particles of sand. Currents carry larvae to the sea, where they feed mainly on copepod larvae and other plankton. After three to four years at sea, they return as adults to spawn.

Eulachon are an important forage fish. Newly hatched and juvenile eulachon are prey for a variety of larger marine fish such as salmon. Marine mammals including seals, sea lions, and beluga whales also feed on them in abundance when the eulachon gather off the mouths of their spawning streams. Spawning eulachon and spent bodies of spawned-out eulachon are eaten by gulls, eagles, and bears, and by the white and green sturgeon (*Acipenser transmontanus*, and *A. medirostris*, respectively) in the larger rivers of southeast Alaska, British Columbia, and the Pacific Northwest. In Alaska, eulachon are seasonally abundant in most major watershed drainages from the southeast and west to Cook Inlet.

Capelin (*Mallotus villosus*)

Information in this subsection is from Brown (2002). The capelin (*Mallotus villosus*) is a major forage fish in the Cook Inlet region. Capelin populations are large and range extensively in Alaskan waters, generally inhabiting pelagic waters. Capelin are mainly filter-feeders, thriving on planktonic organisms such as euphausiids and copepods.

Capelin spawn on beaches and in deeper waters and are highly specific regarding spawning conditions. Temperature, tide, and light conditions are primary criteria for successful spawning; most spawning takes place at night or in dull, cloudy weather. Eggs adhere to the beach and bottom gravels. Most capelin die after spawning. Currently, capelin have no economic value to Alaska; however, the species is preyed on by other fish, marine mammals, and seabirds.

Salmonids

Unless otherwise referenced, information in this subsection is from the National Pacific Fishery Management Council (NPFMC) (2012). The Cook Inlet region is a migratory corridor and early life rearing area for all five species of Pacific salmon (*Oncorhynchus* spp.), Dolly Varden (*Salvelinus malma*), and steelhead trout (*O. mykiss irideaus*). These anadromous (hatch in freshwater, rear in the ocean, then return to spawn in freshwater)fishes transit much of the area, including Shelikof Strait, as smolt leaving natal freshwater drainages and adults later returning to spawn. Juvenile salmonids from Prince William Sound following ocean currents also probably transit much of Shelikof Strait and also may enter Cook Inlet. Salmon in the Cook Inlet, Kodiak, and south Aleutian Peninsula regions contribute significantly to the commercial-fishing industry (see Section 3.3.2). All Pacific salmon die after spawning once, while the other salmonid species may spawn multiple times.

Chinook (King) Salmon (*Oncorhynchus tshawytscha*)

Information in this subsection is from ADFG (2015a). In North America, Chinook (often called King) salmon (*O. tshawytscha*) range from Monterey Bay, California, to the Chukchi Sea, Alaska. For over a decade Chinook salmon numbers have been declining around Alaska prompting ADFG to impose strict limits on harvests in most areas (Schindler et al., 2013). The majority of Chinook salmon in Cook Inlet run in the Susitna River and its tributaries (ADFG, 2013).

Alaskan streams normally receive a single run of Chinook salmon, from May through July. Chinook salmon often make extended freshwater spawning migrations to reach their home streams on some of the larger river systems. Chinook salmon do not feed during the freshwater spawning migration, and their condition deteriorates gradually during the spawning run as their bodies consume stored energy reserves. Eggs usually hatch in late winter or early spring, depending on the timing of spawning and water temperature. Newly hatched fish, live in the gravel for several weeks. In early spring, these juveniles wiggle up through the gravel. In Alaska, most juvenile Chinook salmon remain in freshwater until the following spring when, in their second year of life, they migrate to the sea.

In freshwater, juvenile Chinook salmon feed on plankton and insects. In the ocean, they eat a variety of organisms including herring, pilchard, sand lance, squid, and crustaceans. Salmon grow rapidly in the ocean and often double their weight during a single summer season. Spawning Chinook salmon enter the proposed Lease Sale Area during early May and are present in some spawning streams by the end of the month. During this same period, Chinook salmon juveniles migrate downstream to the North Pacific Ocean.

Coho (Silver) Salmon (*Oncorhynchus kisutch*)

Information in this subsection is from ADFG (2015a). Coho, or silver, salmon (*O. kisutch)* enter the proposed Lease Sale Area in late July, and runs continue until September. Also called silver salmon, coho are found in Alaskan coastal waters from the southeast to Point Hope on the Chukchi Sea, and in the Yukon River to the Alaskan-Yukon border. Coho are extremely adaptable and occur in nearly all accessible bodies of freshwater, from large transboundary watersheds to small tributaries. Their diet includes aquatic insects, zooplankton, and small fish.

Coho salmon enter spawning streams from July to November, usually during periods of high runoff. Eggs develop during the winter and hatch in early spring. Embryos remain in the gravel until emerging in May or June. During autumn, juvenile coho salmon may travel downstream before locating off-channel habitat where they pass the winter free of floods. Some fish leave freshwater in the spring, rear in brackish estuarine ponds, and then move back into freshwater in autumn. They spend one to three winters in streams and may spend up to five winters in lakes before migrating to the sea. Their time at sea varies. Some mature and return after 6 months at sea, while most fish stay 18 months at sea before returning to freshwater watersheds. High-seas tagging shows that maturing southeast Alaska coho move northward throughout the spring and appear to concentrate in the central Gulf of Alaska in June. They later disperse landward and migrate along the coastline until reaching their stream of origin.

Pink Salmon (*Oncorhynchus gorbuscha*)

Information in this subsection is from ADFG (2015a). The pink salmon (*O. gorbuscha*) is native to Pacific and Arctic coastal waters from northern California to the Mackenzie River, Canada; and to the west from the Lena River in Siberia to Korea.

Adult pink salmon enter Alaskan spawning streams between late June and mid-October. Different races or runs with differing spawning times frequently occur in adjacent streams or even within the same stream. Pink salmon have a fixed two-year life cycle, which means that even and odd year spawners are genetically distinct. Most pink salmon spawn within a few miles of the coast, and spawning within the intertidal zone or the mouth of streams is very common. Shallow riffles where flowing water breaks over coarse gravel or cobble-size rock, and the downstream ends of pools are favored spawning areas.

Eggs hatch during early to midwinter. In late winter or spring, larvae swim up and out of the gravel, and migrate downstream into saltwater. The emergence and emigration of larvae is heaviest when it is dark and usually lasts several weeks. Following entry into seawater, juvenile pink salmon move along beaches in dense schools near the surface, feeding on plankton, larval fishes, and occasionally, on insects. Predation is intense on very small, newly emerged fish, but growth is rapid. By autumn, juvenile pink salmon move into offshore feeding grounds in the Gulf of Alaska and waters around the Aleutian Islands. Spawning pink salmon reach the Cook Inlet region annually in early July, where they spawn in most streams of this region. Pink salmon also sometimes spawn in the intertidal zone in some streams. Pink salmon remain in the North Pacific Ocean for two winters before returning to the Cook Inlet region to spawn and die. They are seasonally distributed over most of the area, and are present from spring through early fall annually.

Chum Salmon (*Oncorhynchus keta*)

Unless specified, information in this subsection is from ADFG (2015a). Chum salmon (*O. keta*) range south to the Sacramento River in California and the island of Kyushu in the Sea of Japan. In the north, they range east in the Arctic Ocean to the Mackenzie River in Canada and west to the Lena River in Siberia. Chum salmon are the most abundant commercially harvested salmon species in Arctic, northwestern, and interior Alaska and are a traditional source of dried fish for winter use.

Chum salmon enter the Cook Inlet region beginning in early July, and spawning runs continue through early August. Chum salmon often spawn in small side channels and other areas of large rivers, where upwelling springs provide excellent conditions for egg survival. They also spawn in many of the same places as pink salmon—small streams and intertidal zones.

In contrast to Chinook, coho, and sockeye salmon, chum salmon do not remain in freshwater after hatching. They are similar to pink salmon in this respect, except that chum do not move out into the ocean in the spring as quickly as pink salmon larvae. Chum larvae feed on small insects in streams and estuaries before forming schools in saltwater, where their diet usually consists of zooplankton. By autumn, they emigrate into the Bering Sea or Gulf of Alaska where they spend one or more of the winters of their three- to six-year lives.

Sockeye (Red) Salmon (*Oncorhynchus nerka*)

Information in this subsection is from ADFG (2015a). Sockeye (or red) salmon (*O. nerka*) occur in the North Pacific and Arctic oceans and associated freshwater systems.

Sockeye salmon support one of the most important commercial fisheries on the Pacific coast of North America and are increasingly sought after in recreational fisheries; they remain an important mainstay of many subsistence users.

Mature sockeye salmon travel thousands of miles from ocean-feeding areas to spawn in the same freshwater system where they hatched. Adult sockeye return to Cook Inlet and the Shelikof Strait region annually in late June, and runs continue through early August. Watersheds with lakes produce the greatest number of sockeye salmon. Spawning usually occurs in rivers, streams, and upwelling areas along lake beaches. Eggs hatch during the winter, and the larvae remain in the gravel, living off their yolk sacs until early spring. At this time, they emerge from the gravel and move into rearing areas. In watersheds with lakes, juveniles usually spend one to three years in freshwater before migrating to the ocean in the spring. However, in watersheds without lakes, many juveniles migrate to the ocean soon after emerging from gravel.

Once in the ocean, sockeye salmon grow quickly, returning to their natal stream to spawn after spending one to four years in the ocean. In some areas, populations of sockeye salmon remain in freshwater all their lives. This landlocked form of sockeye salmon, called “kokanee,” reaches a much smaller maximum size than the anadromous form. While inhabiting freshwater, juvenile sockeye salmon feed mainly on zooplankton (e.g., ostracods, cladocerans, and copepods), benthic amphipods, and insects. In the ocean, sockeye salmon feed on zooplankton (e.g., copepods, euphausiids, ostracods, and crustacean larvae), but they also prey on larval and small adult fish (e.g., sand lance), and occasionally squid.

Steelhead Trout (*Oncorhynchus mykiss irideaus*)

Information contained in this subsection is from ADFG (2015a).

Steelhead are found in coastal streams of Alaska from the Dixon Entrance northward and west around the Gulf of Alaska to the Cold Bay area on the Alaska Peninsula. There are no documented populations of steelhead on the Alaskan mainland west of the Susitna River and north of the Chignik River system. Steelhead are unevenly distributed throughout the Cook Inlet, Kodiak, and southern Aleutian Peninsula region. Large numbers are intercepted in high-seas fisheries and, undoubtedly, many of these fish are of Alaskan origin.

Fall-run steelhead enter the watersheds as adults in August, September, and October, and later into the winter. Spawning commences about mid-April and usually continues throughout May and early June. Unlike salmon, steelhead commonly spawn more than once. Spent spawners move slowly downstream to the sea returning to the feeding regions of their first ocean migration. On rare occasions, a fish will return to the spawning stream within a few months, but most repeat spawners spend at least one winter in the sea between spawning migrations. Eggs are deposited deep in the gravel during spring and by midsummer, fry emerge from gravel habitat and seek refuge along stream margins and in protected areas. Generally, juvenile steelhead remain in the parent stream for about three years before emigrating to saltwater.

Dolly Varden (*Salvelinus malma*)

Information in this subsection is from ADFG (2015a). Additional information regarding Dolly Varden in Alaskan waters is from Mecklenburg, Mecklenburg, and Thorsteinson (2002). Dolly Varden are locally abundant in all coastal waters of Alaska. Both anadromous and freshwater varieties exist. Dolly Varden spawn in streams, usually during autumn from mid-August to November. Eggs develop slowly in cold water during the incubation period. Hatching may occur in March; emergence usually occurs in April or May for the southern form. Young Dolly Varden rear in streams before moving to sea. Most Dolly Varden migrate to sea in their third or fourth year, but some linger as long as their sixth year. This migration usually occurs in May or June, although significant but smaller numbers have been recorded migrating to sea in September and October. After their first migration from natal habitat to the sea, Dolly Varden usually spend the rest of their lives wintering in and migrating to and from freshwater. At maturity, Dolly Varden return to spawn in their stream of natal origin.

3.2.2.2. Groundfish

The term “groundfish” loosely groups finfishes that, for much of their time, remain near the seafloor. Spawning and early life, however, may be in pelagic waters. The following groundfish species are considered commercially valuable in the Cook Inlet, Kodiak, and southern Aleutian Peninsula regions (see Section 4.3.11).

Pacific Cod (*Gadus macrocephalus*)

Unless cited otherwise, information in this subsection is from NPFMC (2015). Pacific cod is a largely demersal (bottom-dwelling). Pacific cod are fast growing, maturing in three years. There is concurrently rapid turnover in subpopulations, as predation and commercial fishing take their toll. Pacific cod form aggregations during the peak spawning season, which extends approximately from January through May. The adhesive, demersal eggs hatch in about 13 to 14 days, depending on water temperature. The resultant larvae are pelagic for a time before entering the benthos. Pacific cod feed on pollock, herring, smelt, mollusks, crabs, shrimp, and other similar-sized marine organisms (Hart, 1973).

Pacific Hake (*Merluccius productus*)

Information in this subsection is from NPFMC (2015). The Pacific hake or Pacific whiting (*Merluccius productus*), a codlike fish, may be found throughout the Cook Inlet region, although not in large numbers. Hake spawn for an extended annual period, possibly for up to several months in this region. Eggs are pelagic and hatch quickly (as little as three days) Hake are demersal in nature, although they sometimes make vertical ventures into the water column at night, probably for feeding. Larval hake consume copepods and similarly sized organisms. Adult hake prey on euphausiids, sand lance, anchovies, and other forage fish. In turn, hake are prey for other marine fish, marine birds, and marine mammals.

Pacific Halibut (*Hippoglossus stenolepis*)

Information in this sub section is from NPFMC (2015) and ADFG (2015a). Pacific halibut (*Hippoglossus stenolepsis*) inhabit much of the Cook Inlet proposed Lease Sale Area. Halibut are demersal, and inhabit depths ranging from 50 to 500 m (164 to 1,640 ft).

Spawning takes place during winter months and peaks from December through February. Most spawning takes place on the continental slope in waters 366 to 549 m (1,200 to 1,800 ft) deep. Male halibut sexually mature at seven or eight years of age and females sexually mature at eight to twelve years. Free-floating eggs and larvae float for up to six months and are transported up to several hundred kilometers (miles) by currents of the North Pacific. During the planktonic stage young halibut rise to the surface and are carried to shallower waters by prevailing currents. In shallower waters, young halibut then assume demersal lifestyles. Most young halibut ultimately spend from five to seven years in rich, shallow nursery grounds such as the Bering Sea.

Young halibut, up to 10 years of age, are highly migratory and generally migrate in a clockwise direction east and south throughout the Gulf of Alaska. Halibut in the older age classes tend to be much less migratory. Older fish often use shallow and deep waters over the annual cycle; however, they have much smaller “home ranges” than younger, more migratory fish.

Research indicates there may be small, localized spawning subpopulations in deep waters such as in Chatham Straight in northern southeast Alaska. However, because of the free-floating nature of eggs and larvae, and subsequent mixing of juvenile halibut from throughout the Gulf of Alaska, there is only one known genetic stock of halibut in the northern Pacific. Halibut eat a large variety of fish (for example, cod, turbot, pollock), and some invertebrates (for example, crab and shrimp). Sometimes halibut leave the seafloor to forage on pelagic fish (for example, herring; ADFG, 2015a).

Pacific Ocean Perch (*Sebastes alutus*)

Information in this subsection is from NPFMC (2015). Pacific Ocean perch (*Sebastes alutus*) is representative of 30 rockfish species so far recovered from the Gulf of Alaska and ranges over much of the Gulf of Alaska’s continental shelf and westward Russia. This group is unique in that many are very long-lived, and bear their young alive. The Pacific Ocean perch was formerly a much-sought-after commercial species that was then overexploited.

Adult Pacific Ocean perch usually are found in gravel, rocky, or boulder-strewn substrates in and along the gullies, submarine canyons, and depressions of the upper continental slope. Larvae and juveniles are pelagic, until joining adults in these demersal habitats at two or three years of age.

Sablefish (*Anoplopoma fimbria*)

Information in this sub section is from NPFMC (2015) and ADFG (2015a). Sablefish, or black cod (*Anaplopoma fimbria*), found within the Cook Inlet proposed Lease Sale Area, is a valued commercial species. However, most are harvested outside the proposed Lease Sale Area, because this species usually occurs at depths of 366 to 915 m (1,200 to 3,000 ft). Sablefish are largely demersal in habit, with some nocturnal forays into pelagic waters. Sablefish are a relatively long-lived species, some living to 35 years. The species probably spawns during the spring. Eggs are pelagic, and the young larvae rise to the sea surface (Mason, Beamish, and McFarlane, 1983). Later larval stages occupy waters 150 m (492 ft) in depth. Juveniles typically are found in inside waters in July and August until they mature and return to the spawning areas. Sablefish are indiscriminate feeders on a large variety of benthic and pelagic fauna.

Walleye Pollock (*Gadus chalcogrammus*)

Information in this section is from NPFMC (2015) and ADFG (2015a). Walleye pollock (*Gadus chalcogrammus*), a cod-like species, occurs throughout the proposed Lease Sale Area, with a large spring spawning aggregation that exist in parts of Shelikof Strait. Pollock inhabit pelagic waters in some areas at various times, and are found at depths of 20 to 2,000 m (65 to 6,561 ft). Walleye pollock grow to 91 cm (36 in) long; however, they enter the commercial-trawl fisheries at about 25 cm (12 in) long. Adult pollock consume shrimp, sand lance, herring, small salmon, and similar organisms they encounter. Walleye pollock also are cannibalistic.

Walleye pollock spawn in the spring in large aggregations, although there is extended spawning by smaller numbers throughout the year. Eggs may be close to the surface initially, and hatch in about 10 to 20 days depending on water temperatures. Pelagic larvae remain at the sea surface for up to 30 days, again depending on water temperature, and available food supply. Fisheries survey data indicate larval pollock may use the stratified warmer upper waters of the midshelf to avoid predation by adult pollock residing in colder bottom waters.

Other Groundfish

Lesser numbers of Atka mackerel (*Pleurogrammus monopterygius*), arrowtooth flounder (*Atheresthes stomias*), black rockfish (*Sebastes melanops*), lingcod (*Ophiodon elongatus*), yellowfin sole (*Limanda aspera*), and other groundfish inhabit the Cook Inlet, Kodiak, and southern Aleutian Peninsula region (NPFMC, 2015). These species generally are in the same habitats as the previously discussed groundfish species.

3.2.2.3. Shellfish

“Shellfish” is a collective term that generally refers to harvestable mollusks and crustaceans. The coastal ecosystem of the Gulf of Alaska underwent a shift from an epibenthic community dominated largely by crustaceans to one now dominated by several species of finfish (Anderson, Blackburn, and Johnson, 1997). The reorganization of domineering species in coastal waters resulted from a shift in ocean climate during the late 1970s (Anderson and Piatt, 1999). Analysis of climatological data from the northeast Pacific led Ware (1995) to predict another regime shift to occur in early 2000 so that cold regime conditions would enhance crustacean abundance, while depressing groundfish and salmon numbers (Anderson and Piatt, 1999).

Crabs

Alaskan King Crab

Information in this subsection is from ADFG (2015a). In Alaska, there are three commercial king crab species. Red king crab (*Paralithodes camtschaticus*) occurs from British Columbia to Japan, with Alaskan abundance highest in Bristol Bay and the Kodiak Archipelago. Blue king crab (*P. platypus*) live from southeastern Alaska to Japan, with the highest Alaskan abundance in the Pribilof Islands and St. Matthew Island. They typically do not occur in Cook Inlet (ADFG, 2015a). Golden king crab (*Lithodes aequispinus*) are distributed from British Columbia to Japan, with Alaskan abundance highest in the Aleutian Islands (ADFG, 2015a). Red and blue king crab can occur from the intertidal zone to depths >183 m (600 ft), while golden king crabs live mostly between 183 and 732 m (600 and 1,312 ft) depth, but can occur in depths up to 914 m (3000 ft).

Adult females brood thousands of embryos beneath their tail flap for about a year. When the embryos are fully developed, they hatch as swimming larvae, but tidal currents effectively influence their movements. After feeding on plankton for several months and undergoing several transformations with each molt, larvae settle to the seafloor and molt into non-swimmers. Red and blue king crab settle in waters <27 and 61 m (88 and 200 ft) deep, respectively; while golden king crabs appear to settle in waters 91 m (300 ft) or deeper.

Because a crab's skeleton is its shell (made mostly of calcium), it must molt its shell during growth. Juveniles molt numerous times in their first few years and then less frequently, until they reach sexual maturity in four or five years. Adult females must molt in order to mate. Adult males often skip a molt and keep the same shell for one or two years.

Adult red and blue king crab exhibit nearshore to offshore (or shallow to deep) annual migrations. They move to shallow water in late winter and by spring, the female's embryos hatch. Adult females and some adult males molt and mate before they return to offshore feeding areas in deeper waters. Adult crabs tend to segregate by sex off the mating-molting grounds. Red, blue, and golden king crabs seldom coexist, even though they may inhabit overlapping depth ranges.

Adult male red king crab have been known to migrate up to 161 km (100 miles) round-trip annually, moving at times as fast as 1.6 km (1 mile) per day. Less is known of the migration of golden king crabs, but it is believed they migrate vertically because they generally inhabit steep-sided ocean bottoms.

King crab are opportunist feeders and eat a wide assortment of marine life including worms, clams, mussels, snails, brittle stars, sea stars, sea urchins, sand dollars, barnacles, crabs, other crustaceans, fish parts, sponges, and algae. They also are consumed by a wide variety of predators including, but not limited to, fish (Pacific cod, sculpins, halibut, and yellowfin sole), octopuses, other king crabs which may be cannibalistic, sea otters, and several species of nemertean worms, which eat king crab embryos.

Dungeness Crab (Metacarcinus magister)

Information in this subsection is from ADFG (2015a). The Dungeness crab (*Metacarcinus magister*) is a popular shellfish that inhabits bays, estuaries, and nearshore waters of Alaska. It is widely distributed and can be found as far north as Cook Inlet and Prince William Sound, and as far south as Magdalena Bay, Mexico. This crab supports a commercial fishery and a personal-use fishery in Alaska.

Dungeness crabs mate from spring through autumn. Male crabs are polygamous—each male crab may mate with more than one female crab. This may be an important factor in maintaining the reproductive viability of stocks, because only male crabs can be harvested in commercial and personal-use fisheries.

Male crabs mate with female crabs that have just molted. Egg fertilization does not occur at the time of mating. The female crab stores the sperm until her eggs are fully developed. Eggs are fertilized when the female extrudes them under her abdomen where they are carried until hatching. A large female crab can carry 2.5 million eggs.

After hatching, the young crabs are chiefly planktonic, but capable of freely swimming away from the female parent. Larval development takes from four months to as long as a year in Alaska. Larvae undergo six successive stages (five zoea and one megalopa) before molting into the first juvenile stage. Crabs grow each time they molt. During the first two years, both sexes grow at similar rates but thereafter, female crabs grow more slowly than males. Sexual maturity may be reached at three years. The estimated maximum life span of this crab is 8 to 13 years.

Dungeness crabs are widely distributed subtidally and prefer a sandy or muddy bottom in the sea. However, they are tolerant of salinity changes and can be found in estuarine environments. These crab generally inhabit waters shallower than 27 m (88 ft), but they have been found in depths to 183 m (600 ft).

Dungeness crabs scavenge along the seafloor for organisms that live partly or completely buried in the sand. They are predators, and will consume shrimp, mussels, small crabs, clams, and worms.

Tanner Crabs

Information in this subsection is from ADFG (2015a). Tanner crabs comprise two of the four species of the genus *Chionoecetes* occurring in the eastern North Pacific Ocean and Bering Sea. They form the basis of a thriving domestic fishery from southeastern Alaska north through the Bering Sea. These crabs also are marketed under their trade names: snow crab and Tanner crab (*C. opilio* and *C. bairdi*, respectively).

Tanner crab are brachyuran (short-tailed), or true crab, and constitute some of the most highly specialized of all crustaceans. Tanners may live to an estimated maximum age of 14 years. Males of commercial size usually range from 7 to 11 years of age.

Fertilization is internal, and the eggs usually are ovulated (extruded) within 48 hours onto the female's abdominal flap where they incubate for a year. Hatching occurs late the following winter and spring, with the peak hatching period usually occurring from April to June. This is normally the peak of the spring plankton bloom, and hatching eggs coincide with abundant food resources for the larval crab.

The young, free-swimming larvae molt numerous times and grow through several distinct stages. Growth during this period usually depends on water temperature but lasts about 63 to 66 days, after which the larvae lose their swimming ability and settle to the seafloor. After numerous molts and several years of growth, females mature at approximately five years of age. Males mature at about six years.

Tanner crabs feed on assorted worms, clams, mussels, snails, crabs, other crustaceans, and fish parts. They are consumed by groundfish, pelagic fish, and humans. The sexes are isolated during much of the year but co-inhabit areas during mating season. It is thought that Tanner crabs migrate to shallower waters to mate and lay eggs.

Pandalid Shrimp

Information in this subsection is from ADFG (2015a). Five species of pandalid shrimp of various commercial and subsistence values are found in the cool waters off the coast of Alaska, and two of these are found within Cook Inlet, one of which likely would occur in the proposed Lease Sale Area. Northern shrimp (*Pandalus borealis*) are the foundation of the commercial trawl shrimp fishery in Alaska. Northern shrimp are circumpolar in distribution, though the greatest concentrations occur in the Gulf of Alaska. The Northern shrimp occurs in Cook Inlet. Ranging from Puget Sound to the Arctic coast of Alaska, the humpy shrimp (*P. goniurus*) usually is harvested incidentally with northern shrimp. In some cases, however, the humpy constitutes the primary species caught. Both northern and humpy shrimp usually are marketed as cocktail or salad shrimp.

Coonstripe shrimp (*Pandalus hypsinotis*) is the target of various pot shrimp fisheries around Alaska. Coonstripe shrimp can be found from the Bering Sea to the Strait of Juan de Fuca, while sidestripes (*P. dispar*) range from the Bering Sea to Oregon. This shrimp typically occurs seaward to the mouth of Cook Inlet. Spot shrimp (*P. platyceros*) is the largest shrimp in the North Pacific. Ranging from

Unalaska Island to San Diego, this species is highly valued by commercial pot fishers and subsistence users alike. Most of the catch from the sidestripe, coonstripe, and spot fisheries is sold fresh in local and foreign markets. Spot shrimp can be found in the lower portion of Cook Inlet.

Pandalid shrimp exhibit hermaphroditism, that is, each individual spends the early mature part of its life as a male and later transforms into a female for the balance of its lifetime. For example, a Northern shrimp typically will mature sexually as a male, spawn one or more times, pass through a short transitional phase, and subsequently mature and spawn as a female. In the spring after about a six-month incubation, the eggs hatch into planktonic, free-swimming larvae. By midsummer, the larvae have undergone several molts, rapidly increasing in size after each molt. After the last larval molt, the shrimp transforms into a juvenile and settles to the bottom. After a year or so, the juvenile molts and develops into a mature male and may spawn as a male for one or two seasons. Some juveniles, however, never mature into males; instead, they develop directly into females. The female carries the fertilized eggs until they hatch. Fall-spawning and spring-hatching seasons are the usual case, but timing varies with species and range.

Shrimp inhabit varying depths and habitat types. Spot and coonstripe shrimp generally are associated with rock piles, coral, and debris-covered seafloor; whereas Northern, sidestripe, and humpy shrimp typically occur over muddy seafloor. Northern shrimp occur over the widest depth range (18 to 1,463 m (60 to 4,800 ft)); while humpy and coonstripe shrimp usually inhabit shallower waters (5 to 366 m (16 to 1,200 ft)). Spot shrimp seem to be caught in greatest concentrations around 110 m (360 ft), but are found in depths ranging from 4 to 457 m (13 to 1,500 ft). Sidestripe shrimp typically are found from 46 to 641 m (150 to 2,103 ft), but most concentrations occur in waters deeper than 73 m (239 ft).

Most shrimp migrate seasonally from deep to shallow waters in addition to exhibiting diel migrations vertically within the water column. Northern shrimp, for example, have been observed moving off the bottom in the evening, occupying the whole water column for much of the night and returning to the bottom in the early morning. Pandalid shrimp are opportunistic bottom feeders that eat a wide variety of items such as worms, diatoms, detritus, algae, and various invertebrates. Shrimp often are preyed on by large fish such as Pacific cod, walleye Pollock, flounders, and salmon.

Pacific Weathervane Scallop (*Patinopecten caurinus*)

Information in this subsection is from ADFG (2015a) and NPFMC (2014). The Pacific weathervane scallop is one of several species of true scallops, family *Pectinidae*, found in the eastern North Pacific Ocean. This scallop supports a sporadic but important commercial fishery in Alaskan waters from Yakutat to the eastern Aleutians.

Weathervane scallops are bivalves, with two flattened, shelly valves that are hinged together. Generally weathervane scallops are sexually mature at three or four years, and are of commercially harvestable size at six to eight years. Scallops are found in beds, and are dioecious, having separate sexes. Spawning occurs in June and July where the spermatozoa and ova are released into the water. Ova that are fertilized will settle to the bottom. After approximately one month, hatching occurs and larvae drift with the tidal currents. Over the following two to three weeks, larvae gain shell weight, settle to the bottom, and attach themselves to seaweed. Within four to eight weeks after settling, juveniles develop the ability to swim. At this time, the juvenile scallop assumes the adult form. Growth is very rapid the first few years and is minimal after age 10. Scallops may live for 18 years.

Weathervane scallops have specialized adaptations that help them escape predators or other disturbing conditions. Scallops are the only bivalves whose adult stage is capable of swimming. This ability is accomplished by the rapid release of a jet of water from the interior of the shell. Swimming can be maintained for 15 to 20 seconds and rarely exceeds 6 m (20 ft). Scallops have small tentacles that are highly sensitive to waterborne chemicals and water temperature.

Weathervane scallops are found on seafloors of sand, gravel, and rock from 45 to 183 m (150 to 600 ft) depth. In lower Cook Inlet, they are commercially harvested in Kamishak Bay (Commercial Fisheries Entry Commission, 2007). Weathervane scallops feed by filtering microscopic plankton from the water.

Razor Clam

Information in this section is from ADFG (2015a). The razor clam is an important bivalve mollusk harvested extensively throughout its range by commercial and sport fisheries. The Arctic razor clam (*Siliqua alta*) is found in southern Cook Inlet, and westward to the Bering Sea and Siberia. The Pacific razor clam (*S. patula*) is more widely distributed and is found from Pismo, California, north to the Aleutian Islands. Of the two species, the Pacific razor clam is the more-frequently encountered.

Breeding occurs between May and September and is closely associated with rising water temperatures. Research indicates that a temperature of nearly 13ºC (55ºF) triggers spawning. Sexes are separate in razor clams. In breeding, eggs and sperm are discharged onto wet sand and into seawater. Fertilization occurs by chance. Microscopic larvae have short, hair-like projections called cilia used for propulsion. Toward the end of the larval free-swimming period (veliger stage), which may last from five to 16 weeks, shells begin to form and the young begin to resemble clams. Young clams then take up residence in sand where their growth rate varies from area to area. Some razor clams in Alaska have lived to 18 years, with sexual maturity attained as early as three years of age, and it is possible that older individuals exist.

Razor clams live in surf-swept and somewhat protected sandy beaches. They are found from approximately 1.2 m (4 ft) above the MWL to depths of 55 m (180 ft). Large assemblages of razor clams occur in waters near Augustine Island of western Cook Inlet. Additional large assemblages of razor clams inhabit Kachemak Bay. Razor clams subsist on phyto- and zooplankton filtered from surrounding seawater.

3.2.3. Marine Mammals

The nineteen marine mammal species known to occur in the Cook Inlet region are listed below and described in the following sections. The geographic scope includes the proposed Lease Sale Area as well as the OSRA study areas (Appendix A, Map A-1.1).

Common in the Proposed Lease Sale Area:

- Beluga whale (*Delphinapterus leucas*)
- Dall’s porpoise (*Phocoenoides dalli*)
- Gray whale (*Eschrichtius robustus*)
- Harbor seal (*Phoca vitulina richardii*)
- Harbor porpoise (*Phocoena phocoena*)
- Humpback whale (*Megaptera novaeangliae*)
- Killer whale (*Orcinus orca*)
- Northern sea otter (*Enhydra lutris kenyoni*); and
- Minke whale (*Balaenoptera acutorostra*)

Uncommon in the Proposed Lease Sale Area:

- Baird's beaked whale (*Berardius bairdii*)
- Blue whale (*Balaenoptera musculus*)
- Cuvier's beaked whale (*Ziphius cavirostris*)

- Fin whale (*Balaenoptera physalus*)
- Northern Fur Seal (*Callorhinus ursinus*)
- North Pacific right whale (*Eubalaena japonica*)
- Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
- Sei whale (*Balaenoptera borealis*)
- Sperm whale (*Physeter macrocephalus*)
- Stejneger's beaked whale (*Mesoplodon stejnegeri*)

The marine mammal discussion is divided into two subsections in relation to their ESA status: threatened or endangered species, and non-listed species.

3.2.3.1. Threatened or Endangered Species

Species listed as threatened or endangered under the ESA (16 U.S.C. 1531 *et seq.*) of the United States, and that occur within the Cook Inlet region are included in this section. In some cases, we discuss certain populations or subspecies. Section 3(15) of the ESA, as amended, states:

In the following discussion, we also refer to and discuss specific "population stocks" of threatened and endangered marine mammal species. The Marine Mammal Protection Act (MMPA; 16 U.S.C. 1361 *et seq.*) mandates management of marine mammal population stocks. Under Section 3 of the MMPA, the "…term 'population stock' or 'stock' means a group of marine mammals of the same species, or smaller taxa in a common spatial arrangement, that interbreed when mature" (16 U.S.C. 1362 (11)). "Population stock" (usually referred to simply as "stock") designations of many groups of marine mammals have changed over the past decade, in large part due to focused efforts to define the stocks coupled with the availability of relatively new tools from molecular genetics.

In the cases of marine mammals for which separate stocks have been delineated, we focus our description and evaluation of potential effects on those stocks that may occur within the Cook Inlet region. However, we integrate information on the biological species as a whole if it enhances the understanding of the relevant stock(s) or aids in evaluation of the significance of any potential effects on the stock that occurs within or near the Cook Inlet region.

Under Section 3 of the ESA, the term "critical habitat" for a threatened or endangered species is defined (16 U.S.C. 1532(5)(A)) as:

> "(i) the specific areas within the geographic area occupied by the species, at the time it is listed…, on which are found those physical or biological features:
>
> 1. Essential to the conservation of the species and
> 2. Which may require special management consideration or protection; and
> 3. The specific areas outside of the geographical areas occupied by the species at the time it is listed…, upon a determination by the Secretary [of the Interior] that such areas are essential to the conservation of the species."

The nine ESA-listed species that may occur in the Cook Inlet region are listed in Table 3.2.3-1.

Table 3.2.3-1. Endangered Species Act-Listed Marine Mammal Species in the Cook Inlet Region.

Common Name	Scientific Name	Stock/ESA Status	Critical Habitat in the Region
Beluga whale	*Delphinapterus leucas*	(Cook Inlet Stock)/Endangered	Yes
Humpback whale	*Megaptera novaeangliae*	(Western and Central North Pacific Stocks)/Endangered	None designated
Fin whale	*Balaenoptera physalus*	(Northeast Pacific Stock)/Endangered	None designated

Common Name	Scientific Name	Stock/ESA Status	Critical Habitat in the Region
North Pacific right whale	*Eubalaena japonica*	(Eastern North Pacific Stock)/Endangered	Yes
Sei whale	*Balaenoptera borealis*	(Eastern North Pacific Stock)/Endangered	None designated
Sperm whale	*Physeter macrocephalus*	(North Pacific Stock)/Endangered	None designated
Blue whale	*Balaenoptera musculus*	(Western/Central and Eastern North Pacific Stocks)/Endangered	None designated
Steller sea lion	*Eumetopia jubatus*	(Western U.S. Stock)/Endangered	Yes
Northern sea otter	*Enhydra lutris kenyoni*	(Southwest Alaska Stock) Threatened	Yes

NMFS also designates population stock below its optimum sustainable population, a species or stock below its optimum sustainable population, or a species or population stock listed under the ESA as an endangered or threatened species, as depleted.

The following species descriptions provide information on the relevant biology, ecology, and regulatory history of each species. Less detail is provided for species that rarely occur in or near the proposed Lease Sale Area, or for those species not protected by the ESA.

Beluga Whale (*Delphinapterus leucas*), Cook Inlet Stock – Endangered

Current and Historic Abundance

The Cook Inlet beluga whale population is estimated to have declined from 1,300 animals in the 1970s (Calkins, 1989) to about 340 animals in 2014 (Shelden et al., 2015). The precipitous decline documented in the mid-1990s was attributed to unsustainable subsistence practices by Alaska Native hunters (harvest of >50 whales per year) (Mahoney and Shelden, 2000). In 2006 NMFS suspended the subsistence hunt of Cook Inlet beluga whales in an effort to protect the species.

Current Status and Critical Habitat

Beluga whales are distributed throughout the Arctic and sub-Arctic waters of the Northern Hemisphere (Gurevich, 1980). Their seasonal distribution is affected by tidal conditions, temperature, ice cover, access to food resources, and predator/human interactions (Lowry, 1985). The Cook Inlet beluga stock, one of 5 recognized stocks in Alaskan waters, remains within Cook Inlet throughout the year (Goetz et al., 2012). The degree of genetic difference between the Cook Inlet beluga stock and other stocks indicate they are isolated and genetically distinct, and have probably been so for several thousand years (O'Corry-Crowe et al., 1997, 2002).

Following the cessation of subsistence hunting of Cook Inlet beluga whales in 2006, the population was expected to recover at a growth rate of 2 to 6% per year (Hobbs et al., 2008). However, the population instead declined, at a rate of 1.3% per year between 1999 and 2012 (Hobbs et al., 2012).

In response to the population decline, NMFS designated the Cook Inlet Stock of belugas as depleted under the MMPA in 2000 (65 *FR* 34590, May 31, 2000). In 2006, a status review was initiated and determined that an ESA petition was warranted (71 *FR* 14836, March 24, 2006). In 2008, the Cook Inlet beluga population was listed as endangered under the ESA (73 *FR* 62919, October 22, 2008). The MMPA requires the preparation of a conservation plan for any species or stock designated as depleted; in 2008, NMFS finalized the Conservation Plan for the Cook Inlet beluga (NMFS, 2008a).

In 2011, NMFS designated critical habitat for the Cook Inlet beluga, as required under the ESA (76 *FR* 20180, April 11, 2011). Two areas, consisting of 7,809 km^2 (3,016 mi^2) of marine and estuarine environments considered essential for the species' survival and recovery were designated critical habitat (Figure 3.2.3-1). Area 1 of the Cook Inlet beluga whale critical habitat encompasses all marine waters of Cook Inlet north of a line connecting Point Possession (61.04°N, 150.37°W) and the mouth of Three Mile Creek (61.08.55°N, 151.04.40°W), including waters of the Susitna, Little Susitna, and Chickaloon Rivers below mean higher high water (MHHW) (Figure 3.2.3-1). This area provides important habitat during ice-free months, and is used intensively by Cook Inlet beluga between April and November (NMFS, 2008a).

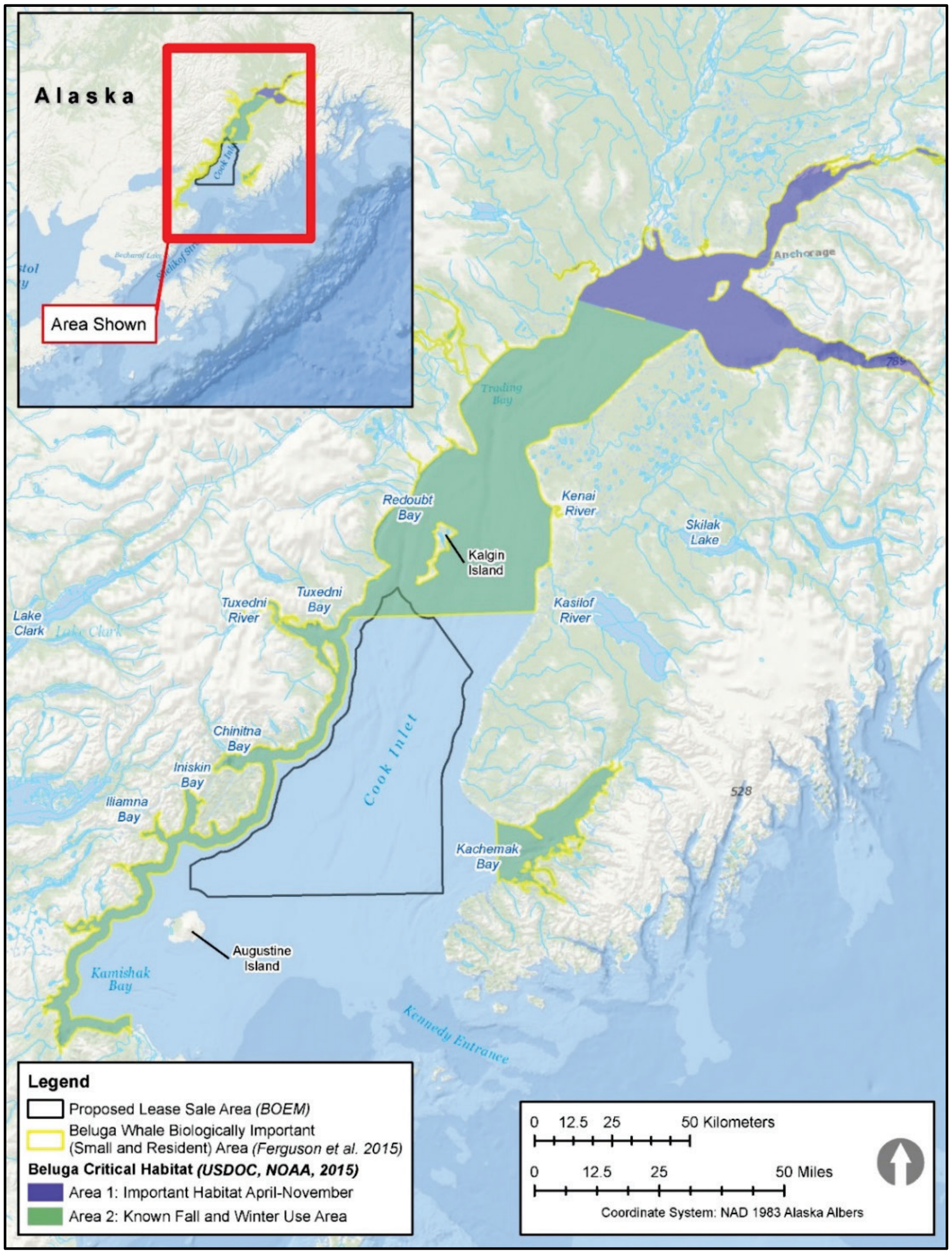


Figure 3.2.3-1. Cook Inlet Beluga Whale Critical Habitat (Area 1 and Area 2). *Figure contains both Beluga critical habitat and and biologically important areas in the Cook Inlet region (Ferguson, Curtis, and Harrison, 2015; NOAA, 2015b).*

Area 2 of the Cook Inlet beluga whale critical habitat includes areas of known fall and winter Cook Inlet beluga use (Figure 3.2.3-1). This area encompasses all marine waters of Cook Inlet south of a line connecting Point Possession and the mouth of Three mile Creek, and north of 60.25°N, including waters within two nmi of MHHW along the western shoreline of Cook Inlet between 60.25°N and the mouth of the Douglas River (59.01°N, 153.75°W); all waters of Kachemak Bay east of 40.00°W; and waters of the Kenai River below the Warren Ames Bridge at Kenai. Area 2 critical habitat supports dispersed fall and winter feeding and transit areas, in waters where Cook Inlet belugas typically occur in smaller densities or deeper waters. It includes nearshore and offshore areas of Cook Inlet, north of a line connecting the village of Tyonek and Point Possession, and nearshore areas of the lower Cook Inlet. Area 2 critical habitat includes fall feeding areas in Tuxedni, Chinitna, and Kamishak Bays on the western side of Cook Inlet, and a portion of Kachemak Bay on the eastern side. Kachemak Bay was included because Cook Inlet belugas commonly occur there: off the Homer Spit, in Mud Bay, and near the head of Kachemak Bay, at Fox River flats (76 *FR* 20180, April 11, 2011).

Current and Historical Habitat Associations and Distribution

Belugas are social animals generally found in small to large aggregations during travel and feeding. Benefits from group cohesion and larger group sizes include reduced risk of predation and cultural transmission of information pertinent to survival (e.g., about prey, calving sites, and oceanographic conditions) (Hamilton, 1971; Reluga and Viscido, 2005).

Though Cook Inlet beluga whales can be found throughout the inlet at any time of year, generally, they spend the ice-free months in the upper Cook Inlet, shifting into the middle inlet in winter (Hobbs et al., 2005). Seasonal movement of Cook Inlet beluga whales appears to be influenced by a variety of factors including water, ice coverage, prey availability, and peak river discharge (Ezer, Hobbs, and Oey, 2008, Ezer et al., 2013; Goetz et al., 2012; Hobbs et al., 2005; Rugh, Shelden, and Hobbs, 2010). Using location data from satellite-tagged Cook Inlet belugas, Ezer et al. (2013) found the majority of tagged whales were located in the lower to middle inlet (70 to 100% of tagged whales) during January through March, near the Susitna River Delta from April to July (60 to 90% of tagged whales) and in the Knik and Turnagain Arms from August to December. Movement was correlated with the peak discharge of seven major rivers emptying into Cook Inlet. Boat-based surveys from 2005 to the present (McGuire, Kaplan, and Blees, 2009), and initial results from passive acoustic monitoring across the entire inlet (Castellote et al., 2011) also support seasonal patterns observed with other methods, and other surveys confirm Cook Inlet belugas near the Kenai River during summer months (McGuire, Stephens, and Bisson, 2014).

Ferguson, Curtis, and Harrison (2015) delineated one Small and Resident Biologically Important Areas (BIAs) for Cook Inlet beluga whales. Small and Resident BIA’s are defined as “areas and time within which small and resident populations occupy a limited geographic extent” (Ferguson, Curtis, and Harrison, 2015). The Cook Inlet beluga whale BIA was delineated using the habitat model results of Goetz et al. (2012) and the Cook Inlet beluga critical habitat boundaries (76 *FR* 20180, April 11, 2011) (see Figure 3.2.3-1). The BIA boundaries include the Cook Inlet beluga Critical Habitat Exclusion Area off Anchorage and Joint Base Elmendorf-Richardson (JBER) (76 *FR* 20180, April 11, 2011), and is a year-round BIA.

Foraging Ecology and Feeding

Data on Cook Inlet beluga prey species come from stomach contents and stable isotope analyses (Quakenbush et al., 2015), and observations from Alaska Native subsistence hunters (Fall, Foster, and Stanek, 1984; Huntington, 2000). These sources found Cook Inlet beluga whales have broad diets that include fish, crustaceans, and cephalopods. Satellite data from tagged whales during winter months suggest whales feed in deeper waters south of the Forelands (Hobbs et al., 2005); possible prey species include flatfishes, sculpins, and gadids.

Quakenbush et al. (2015) analyzed the contents of 28 Cook Inlet beluga whale stomachs collected between March and November in years 2002-2012. Ten of 28 stomachs (36%) were empty. Of the 18 stomachs with food, 17 (94%) contained fish remains, and 9 (50%) contained invertebrates. A minimum of 12 fish species and 8 invertebrate species were identified (Table 3.2.3-2). The 12 fish species represented seven families. Salmon (67% frequency of occurrence), cod (39% frequency of occurrence), smelt (11% frequency of occurrence), and flounder (11% frequency of occurrence) were most prevalent (Table 3.2.3-2).

Table 3.2.3-2. Number and Frequency of Occurrence of Fish Identified from Stomach Contents of Cook Inlet Beluga Whales Collected from 2002-2012

Taxon	Percent Number (n=17)[a]	Percent Frequency (n=18)[a] 94% of stomachs contained fish 50% of stomachs contained only fish
All Catostomidae	1	6
Longnose sucker, *Catostomus catostomus*	1	6
All Osmeridae	12	11
Eulachon, *Thaleichthys pacificus*	12	11
All Salmonidae	38	67
Coho salmon, *Oncorhynchus kisutch*	21	28
Chinook salmon, *Oncorhynchus tshawytscha*	2	11
Chum salmon, *Oncorhynchus keta*	8	17
All Gadidae	42	39
Saffron cod, *Eleginus gracilis*	26	22
Walleye pollock, *Gadus chalcogrammus*	10	17
Pacific cod, *Gadus macrochephalus*	1	6
All Cottidae	1	6
Arctic staghorn sculpin, *Gymnocanthus tricuspis*	1	6
All Stichaeidae	1	6
Slender eelblenny or snake prickleback, *Lumpenus* spp.	1	6
All Pleuronectidae	3	11
Starry flounder, *Platichthys stellatus*	1	6
Yellowfin sole flounder, *Limanda aspera*	2	11
All Unidentified fish	2	11

Note: [a] Percent number is the number of fish from a taxa divided by the total number of all fish eaten (x 100). Percent frequency of occurrence is the number of stomachs that contained a fish taxon divided by the total number of stomachs that contained prey (x 100). Reproduced with permission of lead author.

Source: Quakenbush et al. (2015).

Sources of Mortality

Belugas can live for >60 years, and perhaps as long as 79 years (Stewart et al., 2006; Suydam, 2009). Survival data for Cook Inlet belugas come primarily from beach-cast carcasses and floating carcasses reported to the NMFS Alaska Region, resulting in a minimum annual number of mortalities.

Known and potential sources of mortality and injury and contributing factors to cause of death and injury of Cook Inlet belugas stem from natural and anthropogenic sources; natural sources include predation by killer whales, stranding, malnutrition, disease, trauma, perinatal issues, and environmental issues (Burek-Huntington et al. 2015; NMFS, 2015a). Anthropogenic sources have included subsistence harvest, commercial whaling, poaching and intentional harassment, vessel activities, fisheries activities, research activities, and entanglements, or ingestion of trash and debris. The NMFS Draft Recovery Plan (NMFS, 2015a) extensively outlines these sources of mortality and injury.

Contaminant Levels

Pollution occurs throughout much of Cook Inlet, and several chemical and biological pollution sources have been evaluated by URS Corporation (2010) as sources of concern to belugas. Chemical classes determined to be of probable concern to the Cook Inlet beluga include chlorinated pesticides, chlorinated dielectric fluids, transformer oils, chlorinated dibenzo-p-dioxins and furans, metals, aryl and PAHs. Chemical classes determined to be of possible concern to the Cook Inlet beluga are polybrominated flame retardants and perflourinated compounds. Cook Inlet belugas may be exposed to contaminants found in the water, through inhalation of contaminants in the air, ingestion of contaminants in prey, or from exposure in the abiotic environment (NMFS, 2015a). For the contaminants that have been studied, Cook Inlet belugas generally have lower contaminant levels than do belugas from other populations (Becker, 2009; Becker et al., 2000; CDFO, 2011; Hoguet et al., 2013; Lebeuf et al., 2004; NMFS, 2008a; Reiner et al., 2011; Wetzel, Pulster, and Reynolds, 2010).

Small population size, reduced range, and increasing anthropogenic stressors are among the many conservation concerns that exist for the Cook Inlet beluga population. Several population viability analyses have been conducted on the Cook Inlet beluga population over the years (Hobbs et al., 2008; Hobbs et al., in review as cited in NMFS, 2015a), all of which indicate a population that is likely to continue to decline and face probable extinction within a few hundred years. The Draft Recovery Plan for the Cook Inlet beluga identifies and assesses ten threats to the recovery of the Cook Inlet beluga whale: reduction in prey, pollution, disease agents, noise, habitat loss or degradation, subsistence hunting, predation, unauthorized take, catastrophic events, and cumulative and synergistic effects of multiple stressors.

Humpback Whale (*Megaptera novaeangliae*), Central and Western North Pacific Stocks – Endangered

Current and Historic Abundance

Moore et al. (2002) estimated an abundance of 102 humpback whales (95% confidence interval (CI): 40 to 262 individuals) in the eastern Bering Sea in 2000. Zerbini et al. (2007) estimated an abundance of 2,644 humpback whales (95% CI: 1,899 to 3,680 individuals) for coastal and shelf waters of the central Gulf of Alaska, through the eastern Aleutian Islands. Although a small amount of spatial overlap occurs in these surveys at the eastern Aleutian Islands, these surveys suggest a combined total of about 4,000 whales, a number considerably less than the (Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) combined abundance estimates of 9,000 to 19,000 for the Aleutian Islands, Bering Sea, and Gulf of Alaska. However, the SPLASH surveys were more extensive in scope, including areas not covered in those surveys.

Zerbini et al. (2006) estimated 1,652 whales (95% CI: 1142 to 2398 individuals) along the Aleutian Islands and the Alaska Peninsula (from Kenai to Unimak Pass including Kodiak, the Shumagin Islands, and north of Unimak Pass). Photo-identification studies have estimated 100 to 200 in Prince William Sound and Kenai Peninsula waters (Waite et al., 1999, von Ziegesar et al., 2000), 100 to 150 in the Barren Islands (G. Strong, pers. comm., as cited in Calambokidis et al., 2008), 300 to 500 in Kodiak waters (Waite et al., 1999), and 410 in the Shumagin Islands (Witteveen et al., 2004). The minimum population estimate for the central North Pacific humpback stock is 7,890 (Allen and Angliss, 2015). The minimum population estimate for the western North Pacific humpback stock in 865 (Allen and Angliss, 2015).

Current Status and Critical Habitat

Humpback whales were listed as endangered under the ESA in 1973 (16 USC 1531 *et seq.*) due to the reduced population levels resulting from harvest pressure that occurred in the 20th Century (Perry, DeMaster, and Silber, 1999; Rice, 1978). Humpback whales are listed as depleted under the MMPA. In 1991, the NMFS published a Final Recovery Plan for Humpback Whales (NMFS, 1991).

On May 3, 2001, the NMFS (66 *FR* 29502, May 31, 2001) published a final rule that established regulations applicable to waters within 200 nmi of Alaska, making it unlawful for a person subject to the jurisdiction of the U.S. to approach, by any means, within 91.4 m (100 yd) of a humpback whale. The NMFS also implemented a “slow, safe speed” requirement for vessels transiting near humpbacks, with certain exemptions which can be found in the document (NMFS, 1991).

Critical habitat has not been designated for the central and western north pacific stocks of humpback whales, and both stocks were listed are designated as depleted (Allen and Angliss, 2015).

Current and Historical Habitat Associations and Distribution

In the summer, humpback whales regularly are present and feeding in the Cook Inlet region, including Shelikof Strait, Kodiak Island bays, and the Barren Islands, in addition to Gulf of Alaska regions adjacent to the southeast side of Kodiak Island (especially Albatross Banks), the Kenai and

Alaska Peninsulas, Elizabeth Island, as well as south of the Aleutian Islands (Figure 3.2.3-2). Humpbacks also may be present in some of these areas throughout the autumn (NOAA, 2015b).

Although humpback whales travel to follow prey, they also exhibit a high degree of site fidelity to feeding areas by segregating into discrete feeding aggregations, between which little interchange occurs (Calambokidis et al., 2001; Calambokidis et al., 2008; Waite et al., 1999; Witteveen, et al. 2004). The rate of interchange between Alaska feeding areas (i.e., southeast Alaska, Prince William Sound, the Gulf of Alaska, Kodiak Island, Yakutat Bay, and the Bering Sea) has been found to be <1% (Mizroch et al., 2004). Humpback whales are found in the Cook Inlet region as shown in Figure 3.2.3-2.

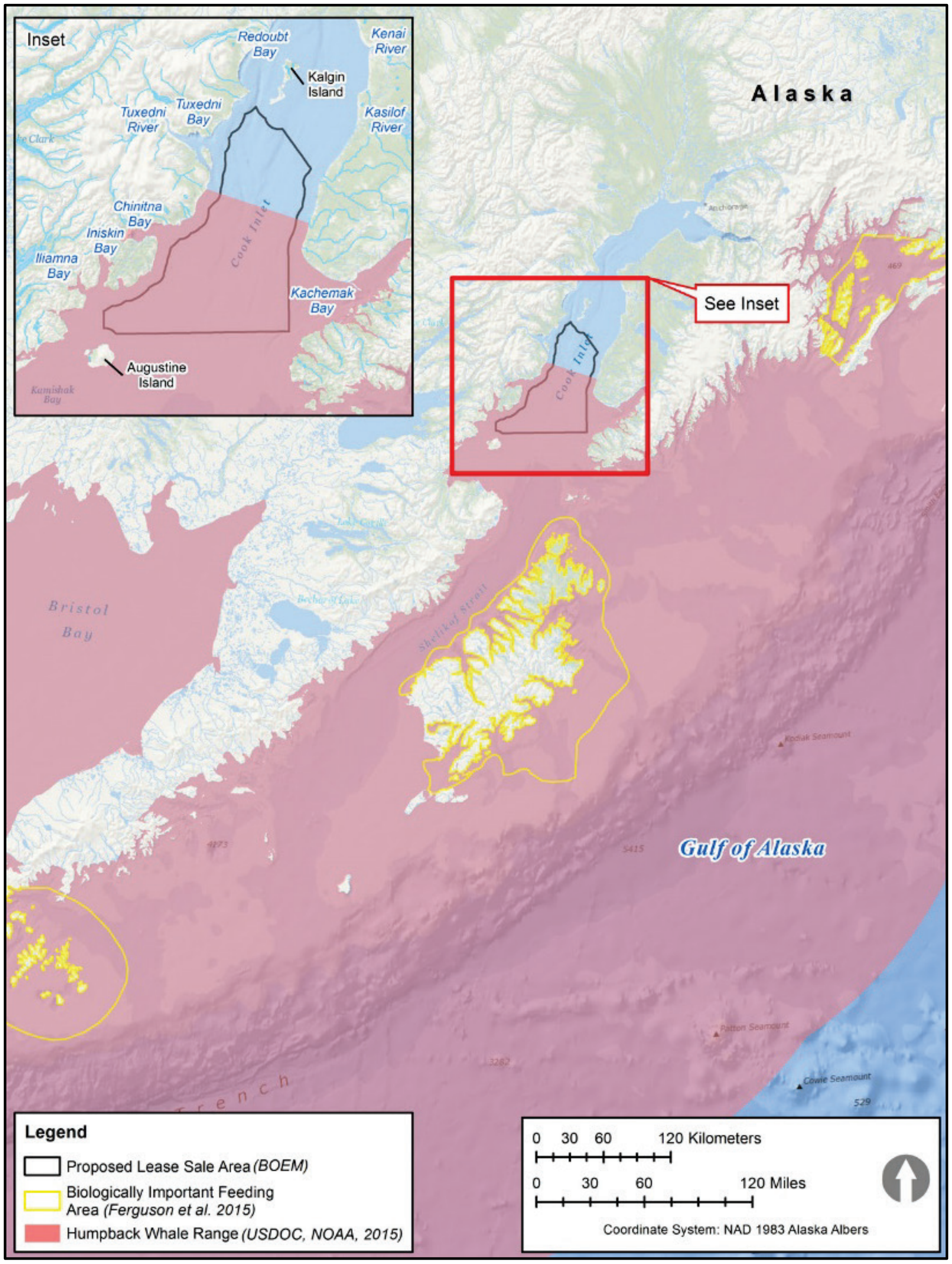


Figure 3.2.3-2. Humpback Whale Range and Biologically Important Areas in the Cook Inlet Region. *Critical Habitat has not Been Designated (Source: Ferguson, Curtis, and Harrison, 2015; NOAA, 2015b).*

The historic feeding range of humpback whales in the North Pacific includes coastal and inland waters around the Pacific Rim from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Johnson and Wolman, 1984; Nemoto, 1957; Tomlin, 1967).

To date, three management units (populations) of humpback whales are recognized in the North Pacific, migrating between their respective summer/fall feeding areas and winter/spring calving and mating areas as follows (Baker et al., 1998; Calambokidis et al., 1997):

1. The California/Oregon/Washington and Mexico population, which is found winter/spring in coastal Central America and Mexico and migrates to the coast of California to southern British Columbia in summer/fall (Calambokidis et al., 1989; Calambokidis et al., 1993; Steiger et al., 1991)
2. The Central North Pacific population, which is found in winter/spring in waters off the Hawaiian Islands and migrates to northern British Columbia/southeast Alaska (including Glacier Bay) and Prince William Sound, west to Kodiak in summer/fall (Baker et al., 1990; Calambokidis et al., 1997; Perry, Baker, and Herman, 1990); and
3. The Western North Pacific population, which occurs in winter/spring off Japan and, based on data obtained on the R/V *Discovery Tag*, probably migrates to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) in summer/fall (Berzin and Rovnin, 1966; Darling, 1991; Nishiwaki, 1966)

A Feeding Area BIA for humpback whales in the Gulf of Alaska region encompasses the waters east of Kodiak Island (the Albatross and Portlock Banks), a target for historical commercial whalers based out of Port Hobron, Alaska (Ferguson et al., 2015; Reeves et al., 1985; Witteveen et al., 2007) (Figure 3.2.3-2). This BIA also includes waters along the southeastern side of Shelikof Strait and in the bays along the northwestern shore of Kodiak Island. The highest densities of humpback whales around the Kodiak Island BIA occur from July-August (Witteveen, pers. comm., 12 January 2015, as cited in Ferguson et al., 2015).

Foraging Ecology and Feeding

Humpback whales feed singly or in groups, employing a wide range of foraging behaviors to capture their prey (Hain et al., 1982). Some common feeding behaviors include lunge-feeding conducted by individual animals, non-synchronized diving behavior, and bubble-net feeding (Hain et al., 1982). Humpback whales feed on small schooling fishes, euphausiids, and other large zooplankton. Fish prey species in the North Pacific include Pacific herring, capelin, juvenile walleye pollock, and sand lance. Humpback also feed on eulachon, Atka mackerel, Pacific cod, saffron cod, Arctic cod, juvenile salmon, and rockfish. Adult animals typically consume up to 3,000 pounds per day, for 6 to 9 months of the year at their summer feeding grounds. A 2015 study found evidence for two sub-aggregations of humpback whales, in the Kodiak Feeding BIA— one aggregation fed consistently on fish and zooplankton species, while the other aggregation predominately foraged on zooplankton (Wright et al., 2015).

Sources of Mortality

Mortality of humpback whales is a result of a combination of natural and anthropogenic causes. Disease may be caused by infectious or toxicological sources; infectious diseases may arise from viral, bacterial, parasitic, or mycotic sources, while toxicological sources of disease include heavy metals, or organochlorine sources (Hain et al., 1982). In addition, humpback whales are known hosts for the parasite *Crassicauda boopis*, a nematode that may cause mesenteric arteritis, occlusion of the blood vessels draining the kidneys, congestive kidney failure, and death (NMFS, 1991). In May 2015, NMFS declared an unusual mortality event (UME) in Alaska (NMFS, 2015c); from May to August 2015, fourteen humpback whales were found dead, with the UME investigation ongoing.

Between 2008 and 2012, there were two mortalities of Western North Pacific humpback whales in the Bering Sea/Aleutian Islands pollock trawl fishery, and one in the Bering Sea/Aleutian Islands flatfish trawl (Allen and Angliss, 2015). Between 2008 and 2012, there was one incidental serious injury and mortality of a central North Pacific humpback whale in the Bering Sea/Aleutian Islands flatfish trawl, and two in the Bering Sea/Aleutian Islands pollock trawl (Allen and Angliss, 2015). Average annual mortality rate due to observed commercial fisheries from 2008 to 2012 for the Central and Western North Pacific Stocks was 0.75 (Allen and Angliss, 2015).

Ship strikes or entangled humpback whales found swimming, floating, or stranded with attached fishing gear occurred in Alaska (Allen and Angliss, 2015). All reports of Alaskan mortalities or injuries of humpback whales from the Central North Pacific Stock from 2008 to 2012 are summarized in Allen, Helker, and Jemison, (2014) and Helker, Allen and Jemison, (2015), along with details regarding injury determination and assessment. The estimated annual human-caused mortality and serious injury rate for 2008 to 2012 based on entanglements (marine debris, commercial and recreational fisheries), as well as vessel collisions reported to the NMFS Alaska Regional Office, Marine Mammal Stranding Database for the Central North Pacific Stock is 7.96, and 1.56 for the Western North Pacific Stock (Allen and Angliss, 2015).

Killer whales prey on humpback whales; in Alaska, 15 to 20% of the photographically identified humpback whales bear scars of killer whale attack (Perry, DeMaster, and Silber, 1999). Apparent shark bites also have been observed on adult animals, and rake marks on the fins and flippers of calves have indicated attacks by false killer whale (NMFS, 1991). A 2008 study examined the incidence of rake marks from killer whales on humpback whale flukes to assess predation pressure throughout the North Pacific (Steiger et al., 2008). The prevalence of rake marks indicated that killer whale predation has the potential to be a major source of mortality (Steiger et al., 2008).

Based on the general category of factors specified as requiring consideration under the ESA, Perry, DeMaster, and Silber (1999) listed the following factors as possibly affecting the recovery of humpbacks in the North Pacific:

- Vessel traffic and oil and gas exploration as types of “Present or threatened destruction or modification of habitat…” (Central North Pacific Stock)
- Whale watching, scientific research, photography, and associated vessel traffic as types of “Overutilization…” (Central North Pacific Stock)
- Entanglement in fishing gear as “Other natural or man-made factors…” (Central North Pacific Stock). Perry, DeMaster and Silber (1999) reported that continued development of coasts and oil exploitation and drilling may lead humpbacks to avoid those areas. Perry, DeMaster, and Silber (1999) noted that humpbacks respond the most to moving sound sources (for example, fishing vessels, low-flying aircraft). Long-term displacement of humpbacks from Glacier Bay and parts of Hawaii may have occurred due to vessel-noise disturbance (see references in Perry, DeMaster, and Silber, 1999)

Fin Whale (*Balaenoptera physalus*), Northeast Pacific Stock – Endangered

Current and Historic Abundance

A minimum estimate of the size of the Alaskan population west of the Kenai Peninsula is approximately 1,368 (Friday et al. (2013), as cited in Allen and Angliss, 2015). An estimate of approximately 4,951 fin whales in the Bering Sea in the summer was made based on visual survey data (95% CI: 2,833 to 8,653 individuals; coefficient of variation (CV) = 0.29). Perry, DeMaster, and Silber (1999) reported a 1991 estimate of 14,620 to 18,630 individuals for the entire North Pacific (Braham, 1991). Zerbini et al. (2006) estimated increasing number of fin whales in coastal waters south of the Alaska Peninsula (near Kodiak and Shumagin Islands). An annual increase of 4.8% was estimated for the period 1987 to 2003 (95% CI: 4.1-5.4%).

Current Status and Critical Habitat

Fin whales were listed as an endangered species under the ESA in 1973 (Perry, DeMaster, and Silber, 1999) and as “depleted” under the MMPA, and later were categorized as a strategic stock. The International Whaling Commission (IWC) began managing the commercial take of fin whales in the North Pacific in 1969 (Allen, 1980; Reeves, Silber, and Payne, 1998a), and legal commercial take of the fin whale was prohibited in 1976. No critical habitat has been designated or proposed for fin whales in the North Pacific.

Current and Historical Habitat Associations and Distribution

In Alaska, fin whales are found as far north as the western Chukchi Sea, the Bering Sea, and throughout the Gulf of Alaska (Clark, 2008). These whales inhabit areas near the proposed Lease Sale Area including Shelikof Strait, and off Kodiak Island—particularly on the west side, and the Gulf of Alaska. The majority of these areas are feeding grounds for the fin whale. Literature suggests that fin whale occurrence varies seasonally, although several studies have documented their presence in most months in the Kodiak Archipelago, and the Shelikof Strait region (Mizroch et al., 2009; Zwiefelhofer, 2002).

Results from a study off western Alaska’s Kenai Peninsula, and the central Aleutian Islands, indicate that fin whales occurred primarily from the Kenai Peninsula to the Shumagin Islands, but were abundant near the Semidi Islands and Kodiak (Zerbini et al., 2006). During a multi-year survey conducted to the south of the proposed Lease Sale Area by Zerbini et al. (2006), fin whales were distributed from the southwestern Kenai Peninsula southwest through the Shelikof Strait and on along the Alaska Peninsula. During a ship survey in 2003, fin whales were concentrated west of Kodiak Island, in Shelikof Strait, and the southern Cook Inlet region. They also were found in fewer numbers over the shelf east of Kodiak to Prince William Sound (National Marine Mammal Laboratory (NMML), 2003). The Ferguson, Curtis, and Harrison (2015) report cited opportunistic aerial surveys conducted by the University of Alaska Fairbanks Gulf Apex Predator-Prey Project (UAF GAP). The project surveyed year-round, every year from 1999 to 2013 in the Kodiak Archipelago and detected fin whales in every month, with the greatest mean number of whales sighted from June through August. From October 1999 to May 2002, fin whales were detected throughout the year by passive acoustic monitoring from six moored hydrophones located hundreds to thousands of kilometers from shore in the Gulf of Alaska (Moore et al., 2006; Stafford et al., 2007). Based on the density of fin whales observed each year and the consistency in annual local concentrations of fin whales east, west, and southwest of Kodiak Island, this area is considered a BIA for feeding fin whales (see Figure 3.2.3-3); the months with the highest number of whales sighted during the 15-year time series of UAF GAP’s aerial surveys were June through August (Ferguson et al., 2015). The feeding area boundary in Figure 3.2.3-3 encompasses the highest density of sightings from Wynne & Witteveen (2005, 2013), and Zerbini et al. (2006), as cited in Ferguson, Curtis, and Harrison, (2015).

Mizroch et al.’s (2009) study indicates that fin whales range across the entire North Pacific from April to October, but in July and August they concentrate in the Bering Sea-eastern Aleutian area (Figure 3.2.3-3). In January and February, fin whales have been sighted in the Aleutian area, and Bering Sea. In the 1960s, 20 fin whales were sighted in the Gulf of Alaska in January (Berzin and Rovnin, 1966). In March, concentrations of fin whales have been seen around Kodiak Island and in the Bering Sea (Berzin and Rovnin, 1966). In April, sightings are generally concentrated around Kodiak Island. In May - July, sightings indicate high use of the Gulf of Alaska and, in June and July, the Bering Sea, while August data show fewer sighting in the Gulf of Alaska (Berzin and Rovnin, 1966). In September and October, sightings indicate that fin whales are in the Bering Sea and the Gulf of Alaska. In November, fin whales still are observed in the Kodiak region while in December, sightings in Alaska have not been documented (Berzin and Rovnin, 1966).

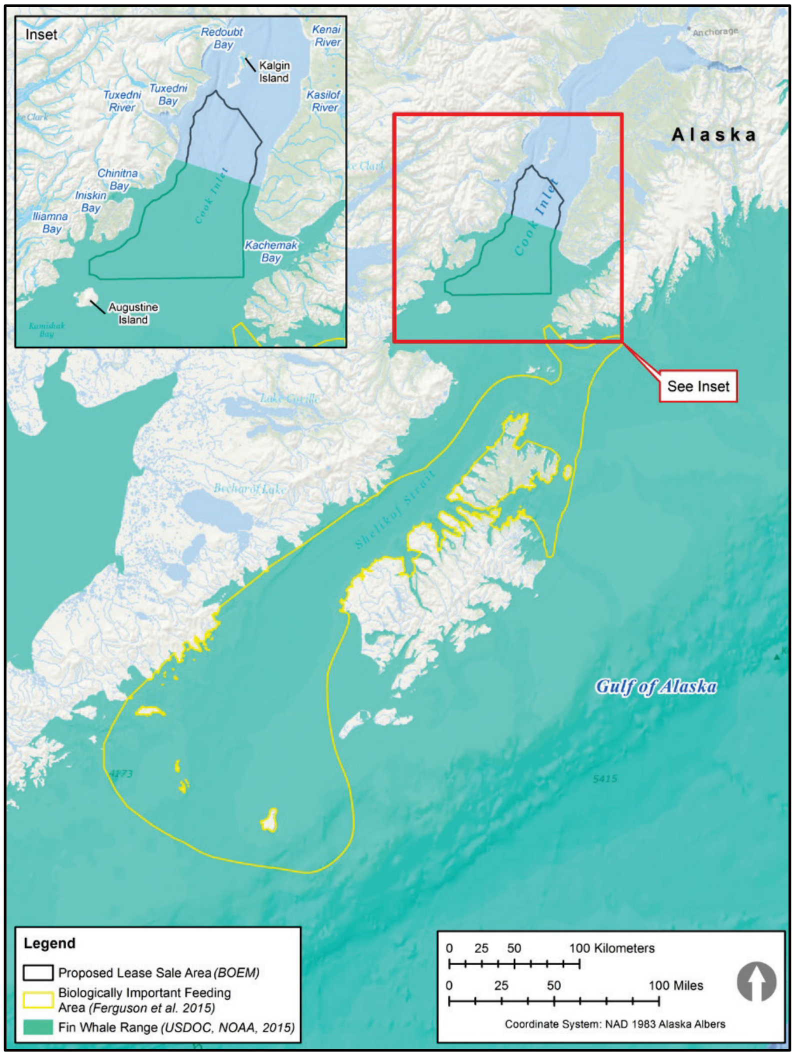


Figure 3.2.3-3. Fin Whale Range and Biologically Important Areas in the Cook Inlet Region. *Critical Habitat has not Been Designated (Source: Ferguson, Curtis, and Harrrison, 2015; NOAA, 2015b).*

Foraging Ecology and Feeding

During the summer, fin whales feed on krill, small schooling fish (e.g. herring, capelin, and sand lance), and squid, by lunging into schools of prey (NMFS, 2013e). Fin whales fast in the winter while they migrate to warmer waters (NMFS, 2013e). Based on stomach contents of whales killed during commercial whaling in the 1950s and 1960s, Nemoto and Kasuya (1965) reported that in the Gulf of Alaska, krill, including the North Pacific krill (*Euphausia pacifica)*, and other genuses (*Thysanoëssa inermis*, *T. longipes*, and *T. spinifera*) were the primary prey of fin whales. However, Mizroch et al. (2009) indicated fish, especially capelin, walleye pollock, and herring are the main prey north of 58°N latitude in the Bering Sea.

Sources of Mortality

There is little information about natural causes of mortality (Perry, DeMaster, and Silber, 1999). Other threats that are discussed in the following paragraph include collisions with vessels, entanglement in fishing gear, reduced prey abundance due to overfishing, habitat degradation, and disturbance from low-frequency noise (NMFS, 2013d). There is no subsistence take of fin whales in the northeast Pacific (Angliss and Lodge, 2002; Angliss, DeMaster, and Lopez, 2001).

Documented human-caused mortality of fin whales in the North Pacific is low, but of all species of large whales, fin whales most often are reported as hit by vessels (Jensen and Silber, 2004). One fin whale death due to vessel strike was reported in the North Pacific in 1991 (Perry, DeMaster, and Silber, 1999), and a fin whale was struck by a vessel in Uyak Bay in 2000 (Neilson et al., 2012). Between 2007 and 2011, there were no observed incidental mortalities of fins whales in any Alaska commercial fishery (Breiwick, 2013).

North Pacific Right Whale (*Eubalaena japonica*) – Endangered

Current and Historic Abundance

North Pacific right whale sightings have been very rare and geographically scattered. In the last three decades, right whale sightings have been so rare that single sightings have sometimes resulted in scientific publications (e.g. Gendron, Lanham, and Carwardine, 1999; Goddard and Rugh, 1998; Herman et al., 1980; Rowntree et al., 1980; Rowlett et al., 1994; Salden and Mickelsen, 1999; Waite et al., 2003; Carretta et al., 2007). The largest number of individuals detected in a single year in this population was 17 in 2004 in the Bering Sea (Wade et al., 2006). North Pacific right whales observed by Wade et al. (2011b) since 1998 in the Gulf of Alaska were all observed in shelf waters adjacent to Kodiak, Alaska. However, NMFS believes that sightings are a function of survey effort (NMFS, 2013a). In support of this caveat, sighting records also indicate that right whales frequently occur far offshore, with observed movements over abyssal depths (Scarff, 1986; Mate, Nieukirk, and Kraus, 1997). Detections of right whales have been very rare in the Gulf of Alaska, even though large numbers of whales were caught there in the 1800s (ADFG, 2015a).

Recent research on the North Pacific right whale suggests that there are approximately 30 whales remaining in the eastern population (Wade et al., 2011b). Wade et al. (2011b) made the first abundance estimates for the eastern North Pacific population using mark-recapture data from the Bering Sea and Aleutian Islands, resulting in abundance estimates of 31 individuals (95 % CI: 23 to 54 individuals), and 28 individuals (95% CI: 24 to 42 individuals) using photographic and genetic identification techniques, respectively. Additionally, Marques et al. (2011) used passive acoustic cue counting to derive a similar abundance estimate of 25 individuals (CV: 29.1%; 95 % CI: 13 to 47 individuals).

Acoustic detection devices in the Gulf of Alaska detected right whale calls on 5 days out of 70 months of sampling from 5 deep water stations. The calls were heard at the deep water station in the Gulf of Alaska approximately 500 km (311 mi) southwest of Kodiak Island in August and September of 2000, but no calls were detected from four other instruments deployed in deep water farther east during 2000 and 2001 (Mellinger et al., 2004). While North Pacific right whales will likely not occur in the proposed Lease Sale Area is it possible they may occur in the Cook Inlet region; as discussed, the eastern side of Kodiak Island has been identified as a feeding BIA of North Pacific right whales (Figure 3.2.3-4) (Ferguson et al., 2015). In the Final Report for the Gulf of Alaska Line-Transect Survey (GOALS) II, Rone et al. (2014) reported that North Pacific right whales were not encountered visually but were acoustically detected with sonobuoys; the North Pacific right whales were documented outside the study area in Barnabas Trough, west-southwest of the inshore stratum. Localizations were obtained on two individuals with a third unique acoustic detection (no localization obtained) about 32 km (20 mi) to the north of the other animals. Possible right whale calls were documented in the inshore stratum.

Current Status and Critical Habitat

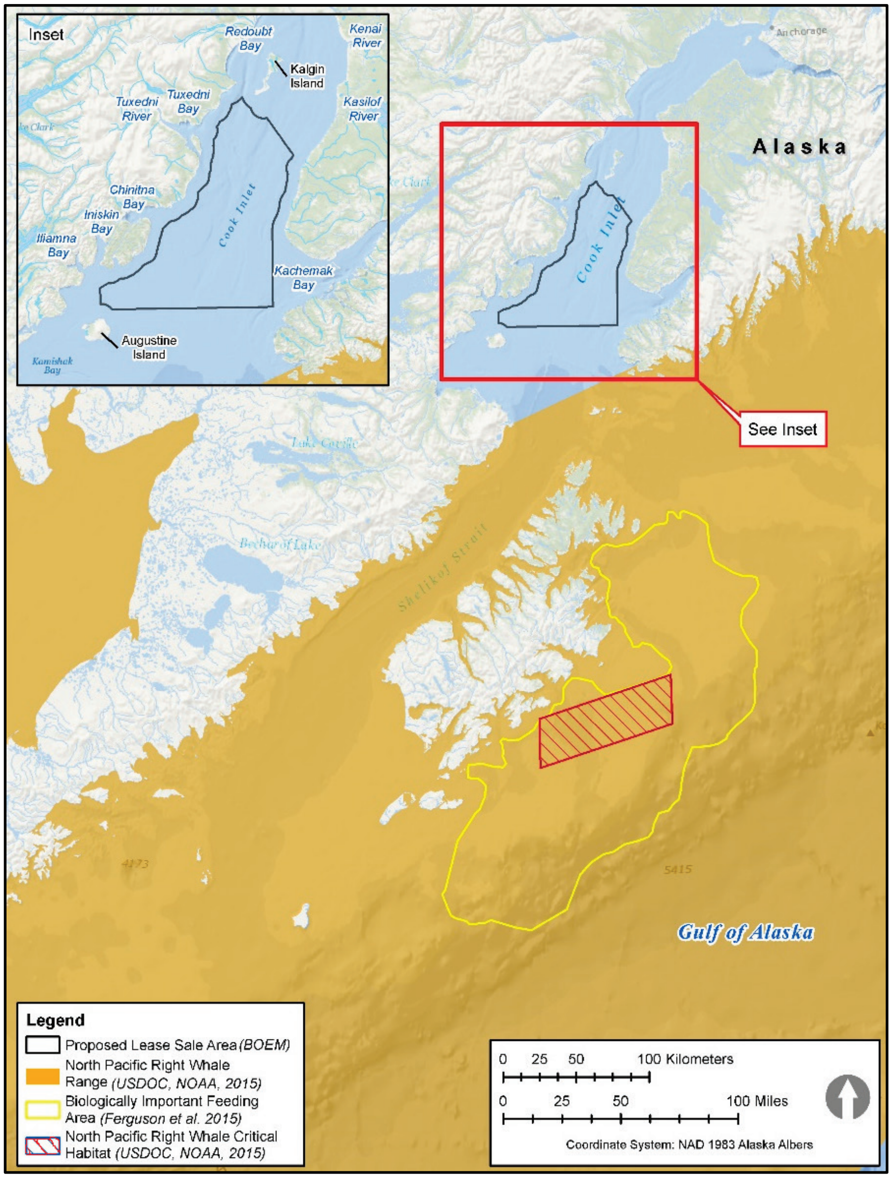


Figure 3.2.3-4. Cook Inlet Region North Pacific Right Whale Range and Biologically Important Areas. *Source: Ferguson et al., 2015; NOAA, 2015.*

The northern right whale, *E. glacialis*, was listed as endangered under the precursor to the ESA of 1973, the Endangered Species Conservation Act of 1969 (35 *FR* 18319, December 2, 1970), and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (NMFS, 2013a). In 2008, the NMFS reclassified the northern right whale as two separate endangered species: the North Pacific right whale (*E. japonica*), and the North Atlantic right whale (*E. glacialis*) (73 *FR* 12024, March 6, 2008) (NMFS, 2013a). In 2008, NMFS designated critical habitats for the North Pacific right whale: one in the southeastern Bering Sea, and another south east of Kodiak Island (70 *FR* 66332, 2 November 2005) (Figure 3.2.3-4). One feeding BIA, also represented in Figure 3.2.3-4 was delineated to the east of Kodiak Island.

Current and Historical Habitat Associations and Distribution

The eastern population of the North Pacific right whale has an estimated historical seasonal migration range extending from the Bering Sea and Gulf of Alaska in the north, down the Pacific coast of the United States to Baja California, Mexico in the south (Figure 3.2.3-4). There are fewer recent sightings of right whales in the Gulf of Alaska than in the Bering Sea (Brownell et al., 2001), although little survey effort has been expended in this region, notably in the offshore areas where right whales commonly occurred during whaling days (Ivashchenko and Clapham, 2012). Though right whales historically have been observed in the Gulf of Alaska (Brownell et al., 2001; Clapham et al., 2004; Scarff, 1986), one location, Albatross Bank, is the only location where right whales have been repeatedly identified in the last four decades (Wade et al., 2011a). Waite et al. (2003) summarized sightings from the Platforms of Opportunity Program from 1959 to 1997. Additional lone animals were observed off Kodiak Island in the Barnabas Canyon area from NOAA surveys in August 2004, 2005, and 2006 (unpublished data from A. Zerbini, cited in Allen and Angliss (2014a)). A single right whale was reported in Pasagshak Bay by a kayaker in May 2010, and one was sighted in December 2011 by humpback whale researchers in Uganik Bay (A. Kennedy, AFSC-NMML, pers. comm. 7 October 2012, as cited in Allen and Angliss 2014a). Several acoustic monitoring studies have shown detections of right whales off of the coast of Kodiak in the early 2000s (Mellinger et al., 2004), and several detections in recent years (AFSC, 2014; Rone et al., 2014).

The North Pacific right whales are thought to have had high concentrations north of 40ºN during summer, and to migrate southward in autumn (Clapham et al., 2004). This seasonality in the occurrence of North Pacific right whales in Alaskan waters is supported by passive acoustic data from long-term bottom-mounted hydrophones deployed on the Bering Sea shelf from October 2000 to January 2006, which detected right whale calls from May to December, with more detections from July through October than May to June or November to December (Munger et al., (2008), as cited in Ferguson et al., 2015).

Based on acoustic recordings of right whale call patterns from 2000 to 2006, Munger et al. (2008) found that whales remain in the southeastern Bering Sea later in the year than was previously thought, and move into mid-shelf waters intermittently throughout the summer (Allen and Angliss, 2014a). More recent acoustic monitoring detected right whale vocalizations year-round in the Bering Sea, although calls become far less common in mid-winter (Baumgartner, Esch, and Zerbini, 2009; Esch et al., 2009).

Foraging Ecology and Feeding

Right whales are thought to feed largely on copepods, but also euphasiids (Gregr and Coyle, 2009; IWC, 1986; Shelden et al., 2005; Wade et al., 2011a), and are skim (“ram”) feeders, continuously filtering through their baleen, while moving through a patch of zooplankton. This feeding strategy requires exceptionally high prey densities (Baumgartner et al., 2003; Baumgartner et al., 2011; Baumgartner and Mate, 2003). Stomach content analysis revealed that right whales feeding in the Gulf of Alaska, Sea of Okhotsk, and the eastern Aleutian Islands consume primarily the following copepods: *Neocalanus plumchrus*, *Metridia sp*. and *N. Cristatus*, respectively (Omura, 1958; Omura, 1986; Omura et al., 1969). The predominant prey species in the southeastern Bering Sea is *Calanus marshallae* (NMFS, 2013a). Based on repeated detections of right whales in the Barnabas Trough and Albatross Bank area, including animals that were recently feeding (based on the observation of feces), this area is considered a BIA for feeding (Ferguson et al. (2015); Figure 3.2.3-4).

Sources of Mortality

Given the small population sizes, and limited sampling opportunities, there is little new information on mortality rates of the eastern and western North Pacific right whale populations (NMFS, 2013). Natural mortality is likely similar to that of western North Atlantic right whales (17% in yearling, and

3% in sub-adult whales; Kraus (1990)). A 27% overall sub-adult mortality rate including deaths attributable to anthropogenic sources (Kraus, 1990) is likely an overestimate for the North Pacific, where ship strikes and entanglements almost certainly occur far less frequently than in the North Atlantic because fishing and shipping activities are less intense in North Pacific waters plied by right whales than they are in western North Atlantic right whale habitats (NMFS, 2013).

The most significant threat to the eastern population is its extremely small size; there is a heightened risk of extinction if individuals are removed from the population (NMFS, 2013). Past commercial whaling has left small, remnant populations of North Pacific right whales vulnerable to low genetic variability, exacerbated by genetic drift and inbreeding (Lacy, 1997). Low diversity potentially affects individual whales by depressing fitness, lowering resistance to disease and parasites, and diminishing a whale's ability to adapt to environmental change (Lacy, 1997). At the population level, low genetic diversity can lead to slower growth rates, lower resilience, and poorer long-term fitness (Lacy, 1997).

Although the main direct threat to the species was addressed by the IWC's 1982 moratorium on commercial whaling, several potential threats remain. Among the current potential threats are environmental contaminants; reduced prey abundance or location due to climate change; increased risk of ship collisions; and exposure to anthropogenic noise. In the NMFS 2013 Recovery Plan for the North Pacific right whale, the following threats were identified:

- Anthropogenic noise
- Ship noise
- Oil and Gas Exploration and Development
- Military Sonar and Explosives
- Vessel Interactions
- Ship Strikes
- Disturbance from Whale Watching and Other Vessels
- Contaminants and Pollutants
- Disease
- Interactions with Trash and Debris and Commercial Fishing
- Research
- Predation and Natural Mortality
- Directed Hunting
- Competition for Resources
- Loss of Prey Base Due to Climate and Ecosystem Change

Sei Whale (*Balaenoptera borealis*), Eastern North Pacific Stock – Endangered

Current and Historic Abundance

The sei whale habitat range does overlap with the OSRA study area in the central Gulf of Alaska (Consiglieri et al., 1982; Manly, 2007; Rone, 2014; NOAA, 2015b; Appendix A, Map A-1). The largest known concentration of sei whale in the Gulf of Alaska occurs during summer, near and just east of Portlock Bank (Fiscus et al., 1976). Fiscus et al. (1976) speculated that sei whales may occur in the eastern and central Gulf of Alaska, as right whales historically did (Townsend, 1935), because both species prey on euphausiids. NMFS has provided a minimum population estimate of 83 for the Eastern North Pacific Stock of sei whales (Carretta et al., 2015).

Current Status and Critical Habitat

The sei whale has been listed as "endangered" under the ESA since 1973, and the Eastern North Pacific Stock is categorized under the MMPA as depleted, and as a strategic stock (Allen and Angliss, 2015). On the basis of total abundance, current distribution, and regulatory measures that are currently in place, it is unlikely this stock is in danger of extinction (Braham 1992 as reported in Allen and Angliss, 2015).

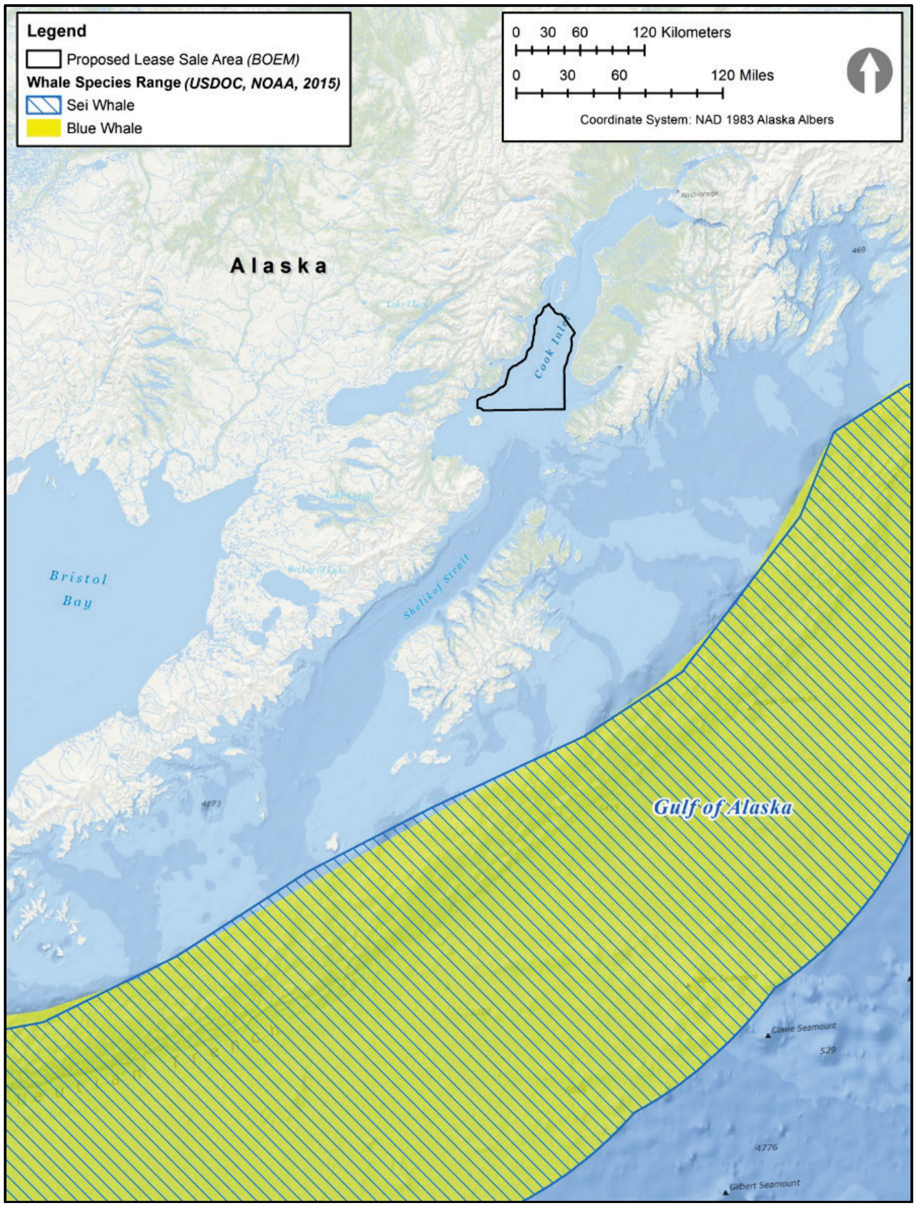


Figure 3.2.3-5. Sei Whale and Blue Whale Species Ranges in the Cook Inlet Region. *Critical Habitat has not Been Designated. (Source: NOAA, 2015b).*

Current and Historical Habitat Associations and Distribution

Poleward summer feeding migrations occur, and sei whales generally winter in warm, temperate or subtropical waters (Horwood, 1987; Jefferson, Webber, and Pitman, 2008). Throughout their ranges (Figure 3.2.3-5), sei whales occur predominantly in deep water; they are most commonly observed over the continental slope (Cetacean and Turtle Assessment Program, 1982; Martin, 1983; Mitchell, 1975; Olsen et al., 2009), shelf breaks (Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2003), and deep ocean basins situated between banks (Sutcliffe and Brodie, 1977).

In the North Pacific Ocean, the sei whale has been reported mainly south of the Aleutian Islands (Leatherwood et al., 1982; Nasu, 1974), although Masaki (1977) reported concentrations in the northern and western Bering Sea from July through September. Available evidence indicates that the range of sei whales in the Bering Sea is limited to the southeastern corner of the deep southwestern Aleutian Basin (Gambell, 1985; Rice, 1998).

Foraging Ecology and Feeding

Studies in various ocean basins indicate that sei whales are associated with ocean fronts and eddies (Bost et al., 2009; Nasu, 1966; Nemoto and Kawamura, 1977; Skov et al., 2008), oceanographic features that concentrate prey and are dependent on prevailing currents. Sei whales also may use currents in large-scale movements or migrations (Olsen et al., 2009). In addition to calanoid copepods and euphausiids, sei whales in the North Pacific reportedly prey on "almost every gregarious organism occurring with large biomass," including pelagic squid and fish the size of adult mackerel (Kawamura, 1982; Nemoto and Kawamura, 1977). Based on analysis of contents of 1,453 sei whale stomachs from whales caught in a commercial hunt off British Columbia between 1963 and 1967, Flinn et al. (2002) found that copepods were the dominant prey. Euphausiids and several fish species (including saury (*Cololabis saira*), whiting (*Merlangius merlangus*), lamprey, and herring) were also present (NMFS, 2011a). In another study that examined the contents of 489 sei whale stomachs taken from waters east and northeast of Japan and west of 170°E from 2000 to 2007, Tamura et al. (2009) found 12 prey species, including three copepod, three euphasiid, five fish (including varieties of anchovy, saury, and mackerel), and one squid species.

Sources of Mortality

No estimates of natural mortality rates are available for sei whales in the North Pacific, and little is known about causes of natural mortality (NMFS, 2011). Predation by killer whales and sharks, particularly on young or sick individuals, may occur, but such events have not been reported in the North Atlantic (Ford and Reeves, 2008) or the North Pacific.

One ship strike death was reported in Washington in 2003 (NMFS Northwest Regional Office, unpublished data, as reported in Carretta et al., 2015). During 2004-2008, there were an additional eight injuries of unidentified large whales attributed to ship strikes. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. The average observed annual mortality due to ship strikes is zero sei whales per year for the period 2004-2008.

Threats to the sei whale include fishery interaction, anthropogenic noise, vessel interactions, contaminants and pollutants, disease, injury from trash and debris, research, predation and natural mortality, directed hunting, competition for resources, and loss of prey base due to climate and ecosystem change There have been no documented fisheries-associated mortalities of sei whales in the eastern North Pacific since at least 2004 (Carretta et al., 2015).

Sperm Whale (*Physeter macrocephalus*), North Pacific Stock – Endangered

Current and Historic Abundance

Sighting surveys conducted by the NMML in summer months between 2001 and 2010 found sperm whales to be the most frequently sighted large cetacean in the coastal waters around the central and western Aleutian Islands (NMML, unpublished data, as cited in Allen and Angliss, 2015). Acoustic surveys detected the presence of sperm whales year-round in the Gulf of Alaska, although they appear to be more common in summer than in winter (Mellinger et al., 2004). Current and historic estimates for the abundance of sperm whales in the North Pacific are considered unreliable; however, the abundance of sperm whales in the North Pacific was reported to be 1,260,000 prior to exploitation, which by the late 1970s was estimated to have been reduced to 930,000 whales (Rice 1989). The number of sperm whales of the North Pacific occurring within Alaska waters remains unknown (Allen and Angliss, 2015), though estimates (Kato and Miyashita, 1998) indicated the presence of 102,112 sperm whales in the Western North Pacific.

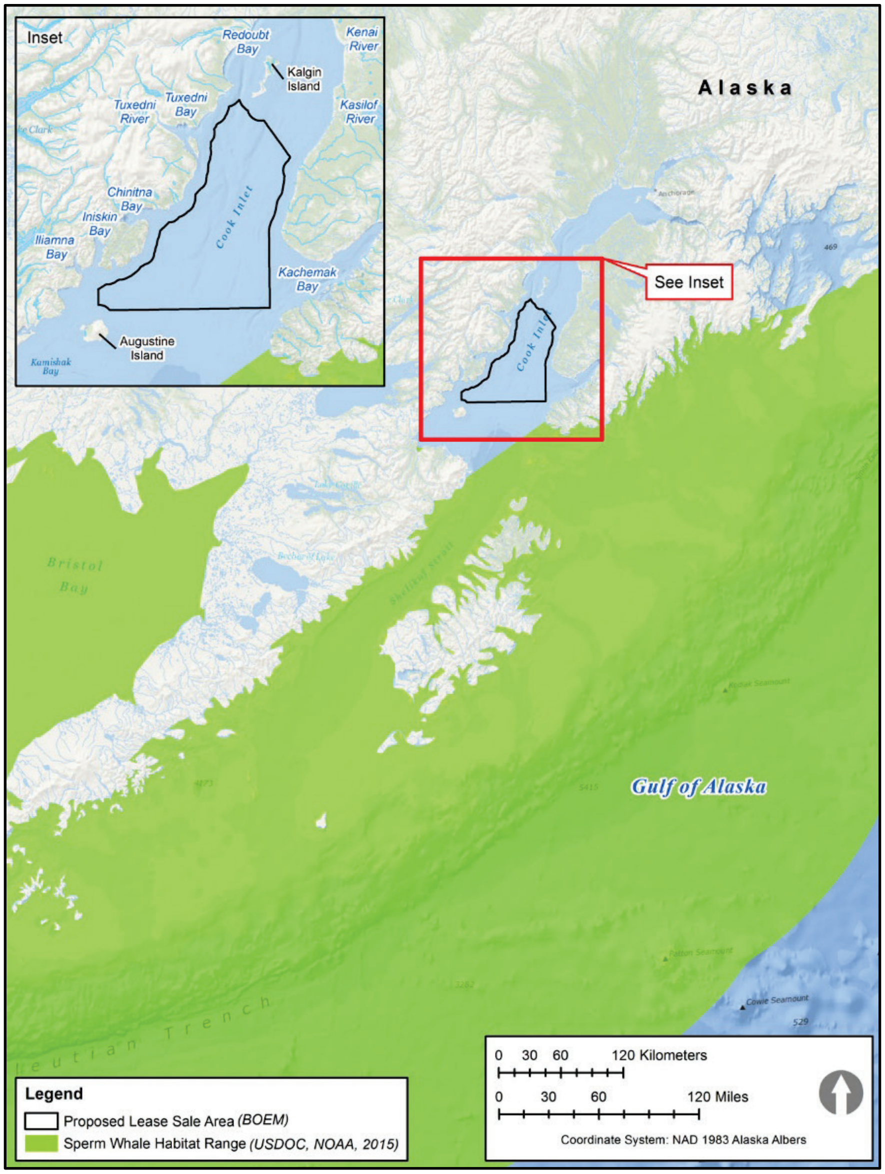


Figure 3.2.3-6. Sperm Whale Species Range in the Cook Inlet Region. *Source: NOAA, 2015b.*

Current Status and Critical Habitat

The NMFS recognizes three stocks of sperm whales in the eastern North Pacific: the Alaska (North Pacific Stock), California/Oregon/Washington Stock, and Hawaii Stock (Angliss et al., 2001). Sperm whales are listed as endangered under the ESA of 1973, and depleted, and a strategic stock under the MMPA (Allen and Angliss, 2015). Consequently the North Pacific Stock is classified as a strategic stock.

Current and Historical Habitat Associations and Distribution

Sperm whales are found in the Gulf of Alaska, along the Aleutian Islands, and in the deeper waters of the Bering Sea primarily during the summer, and tend to be mostly mature males that have moved north from wintering areas to feed (Berzin and Rovnin, 1966; Mellinger et al., 2004; NMFS, 2010a) (Figure 3.2.3-6). Sperm whales commonly are found in waters >300 m depth, and often are concentrated in upwelling areas and along the outer continental shelf and mid-ocean areas (Rice, 1989).

Several population estimates are summarized in Perry, DeMaster, and Silber (1999), Angliss, DeMaster, and Lopez (2001), and in the Alaska Marine Mammal Stock Assessments (Allen and Angliss, 2015).

Foraging Ecology and Feeding

Sperm whales are deep and prolonged divers, and therefore can use the entire water column, even in very deep areas (NMFS, 2010a). Most sperm whales feed anywhere from 500 to 1000 m (1,640 to 3,281 ft) depth where most of their food is found. Lockyer (1981) estimated that they consumed about 3.0 to 3.5% of their body weight per day. Male sperm whales feed in the summer in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Kasuya and Miyashita, 1988; Mizroch and Rice, 2012). Sperm whales feed primarily on larger mesopelagic cephalopod and fish species, including the giant squid (Perry, DeMaster, and Silber, 1999). Sperm whales feed primarily on medium-sized to large-sized squids but also take substantial quantities of large demersal and mesopelagic sharks, skates, and fishes (Rice, 1989). The four most common prey of sperm whales in the North Pacific off central California are cephalopods (i.e., *Moroteuthis*, *Gonatopsis*, *Histioteuthis*, and *Galiteuthis*) (Fiscus, Rice, and Wolman, 1989). In the last 20 years sperm whales have been documented eating sablefish and other fish species off longline fishing gear in the Gulf of Alaska (Hill and Mitchell, 1998; Hill et al., 1999; Perez, 2006; Sigler et al., 2008).

Sources of Mortality

There are six commercial fisheries operating within the range of the North Pacific stock. No mortalities of sperm whales have been observed by NMFS fisheries observers, or self-reported by fishers between 2008 and 2012 (Allen and Angliss, 2015). Angliss et al. (2001) report that: "…based on the lack of reported mortalities (by fishermen), the estimated annual mortality rate incidental to commercial fisheries is zero."

There are no reports of subsistence hunters taking sperm whales (Rice, 1989). Between 1947 and 1987, 258,000 sperm whales were reported to be taken by commercial whalers in the North Pacific (C. Allison, pers. communication, cited in Angliss et al., 2001). However, due to 60% underreporting by the Soviets between 1949 and 1971 (Brownell et al., 1998), this number is likely an underestimates of actual take.

From 2006-2010, there were 11 sperm whale mortalities reported to Alaska Region Stranding Program (NMFS Alaska Regional Office, unpublished data, as cited in Allen and Angliss, 2015).

Blue Whale (*Balaenoptera musculus*), Eastern and Central North Pacific Stocks – Endangered

Current and Historic Abundance

The minimum population estimate for Eastern North Pacific stock of blue whales is approximately 1,551, and the minimum population estimate for the Central North Pacific Stock of blue whales is 38 (Carretta et al. 2015). The estimate for the Central North Pacific Stock was based on a survey conducted within the Hawaii EEZ, when the majority of blue whales from this stock would be expected to be at higher latitudes feeding grounds at this time of year (Carretta et al. 2015).

Blue whale sightings within the Gulf of Alaska and Cook Inlet have been rare (Morris, Alton, and Braham, 1983). Consiglieri et al. (1982) reported two sightings in the Gulf of Alaska of two individuals in May 1960 on the Portlock Bank, and five individuals in June 1969 over the Gulf of Alaska. NMFS records include two sightings during the summer – one individual blue whale in July of 1975 above the Albatross Bank, and one individual in August 1978 near Chirikof Island (Morris, Alton, and Braham, 1983). No blue whales were observed during an extensive summer survey of the Gulf of Alaska in 1980 (Rice and Wolman, 1982). In the Final Report for the Gulf of Alaska Line-Transect Survey (GOALS) II, Rone et al. (2014) reported that blue whales were detected on three sonobuoys deployed in the seamount stratum, blue whales only were seen in the seamount stratum and their density was much lower if compared to other baleen whales, and during a survey in 2012, four blue whales were documented on a transect located south of the Gulf of Alaska (Rone et al., 2014).

Current Status and Critical Habitat

All blue whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the Central North Pacific, and Eastern North Pacific stocks are automatically considered to be "depleted" and "strategic" stocks under the MMPA. No critical habitat for blue whales has been designated in Alaskan waters (Carretta et al., 2015). Though the annual mortality rate remains 1.9/year, a value below the 2.3 Potential Biological Removal (PBR) threshold, it is assumed unreported vessel strikes in the California Current likely exceeds the PBR for the Eastern North Pacific Stock (Redfern et al. 2013).

Current and Historical Habitat Associations and Distribution

The blue whale is listed as an endangered species throughout its range. Studies of intraspecific variability have led to the designation of three subspecies (Rice, 1977): *B. m. musculus* in the Northern Hemisphere; the somewhat larger *B. m. intermedia* from the Antarctic; and *B. m. brevicauda*, the so-called "pygmy" blue whale, a significantly smaller and morphologically distinct form found in the sub-Antarctic zone of the southern Indian Ocean, and southwestern Pacific Ocean (Ichihara, 1966). For management purposes NMFS currently identifies two stocks in the U.S. Pacific EEZ; the central North Pacific stock and the eastern North Pacific stock. Both occur in the Gulf of Alaska (Allen and Angliss, 2014a).

In Alaska, the species is found primarily south of the Aleutian Islands and the Bering Sea (Nishiwaki, 1966; Reeves et al., 1985) (Figure 3.2.3-5). It is assumed that blue whale distribution is governed largely by food requirements, and that populations are seasonally migratory (NMFS, 1998). Poleward movements in spring allow the whales to take advantage of high zooplankton production in summer (NMFS, 1998).

Foraging Ecology and Feeding

Specific studies on feeding habits of blue whales in Alaska have not been conducted, therefore, studies of blue whales off the California coast and elsewhere in the North Pacific were used as proxies. In those studies blue whales preyed mainly on *E. pacifica*, and secondarily on the somewhat larger krill species *T. spinifera* (Rice, 1986). However, recent studies in coastal waters of California have found blue whales feeding primarily on the latter (Fiedler et al. (1998; Kieckhefer et al., 1995; Schoenherr, 1991), as cited in NMFS (1998)). The species *T. inermis*, *T. longipes*, *T. raschii*, and *Nematoscelis megalops* have also been listed as prey of blue whales in the North Pacific (Kawamura, 1980; Yochem and Leatherwood, 1985). Reports that they feed on small schooling fish and squid in the western Pacific (Mizue, 1951; Sleptsov, 1955) have been interpreted as suggesting that the preferred zooplankton are less available there (Nemoto, 1957).

Sources of Mortality

Because there have been no reported fishery related mortality or serious injuries of blue whales the total fishery-related mortality and serious injury of this stock can be considered to be insignificant and approaching zero (Carretta et al., 2015).

Collisions with vessels, entanglement in fishing gear, reduced zooplankton production due to habitat degradation, and disturbance from low-frequency noise are listed as threats (NMFS, 1998). Thus, unlike the more piscivorous baleen whales (e.g. the humpback whale, fin whale, minke whale, and Bryde's whale, *Balaenoptera edeni*), the blue whale in the Northern Hemisphere is probably not yet competing directly with humans for prey resources (NMFS, 1998). Perhaps largely because of its offshore distribution, the blue whale seems less prone to, although not immune from, lethal entanglements in fishing gear, and lethal strikes by vessels (NMFS, 1998).

A well-documented observation of killer whales attacking a blue whale off Baja California, Mexico proves that blue whales are at least occasionally vulnerable to these predators (Tarpy, 1979). A high proportion of the blue whales in the Gulf of California bear injuries or rake-like scars that are the result of encounters with killer whales (Sears, 1990; NMFS, 1998). Unlike in the western North Atlantic, injury or suffocation from ice entrapment is not known to be a factor in the natural mortality of blue whales in the North Pacific (NMFS, 1998).

Increasing levels of anthropogenic noise in the world's oceans has been suggested to be a habitat concern for blue whales (Reeves et al. 1998). Historically at least 9,500 blue whales were taken by commercial whalers throughout the North Pacific between 1910 and 1965 (Ohsumi and Wada, 1972). Some proportion of this total may have been from a population or populations that migrate seasonally into the Hawaiian EEZ. The species has been protected in the North Pacific by the IWC since 1966 (Carretta et al., 2015).

Steller Sea Lion (*Eumetopia jubatus*), Western Distinct Population Segment – Endangered

Current and Historic Abundance

The 2014 Stock Assessment Report lists a minimum population estimate of 48,676 for the U.S. portion of the WPDS of Steller sea lions (Allen and Angliss, 2015). The overall Steller sea lion WDPS is estimated to have increased at an annual rate of 1.67% from 2000 to 2012 (Allen and Angliss, 2015). Count data used to estimate population trends and evaluate population status are of two types: counts of pups approximately 1 month of age, and counts of animals >1 year of age (i.e. non-pups) (NMFS, 2008b). Recent abundance estimates for the western stock of Steller sea lions are derived from aerial photographic surveys of non-pups in June and July of 2008 to 2012, and aerial photographic and ground-based pup counts conducted in June and July of 2009 to 2012 (DeMaster, 2011, 2012). A total of 34,056 non-pups were counted during the 2008 to 2012 surveys, 19,593 in the Gulf of Alaska and 14,463 in the Bering Sea/Aleutian Islands. The composite pup count of the western stock in Alaska from 2009 to 2012 totaled 11,603 individuals. Figure 3.2.3-8 shows the counts of adult and juvenile Steller sea lions at rookery and haul-out sites throughout the range of the western U.S. stock in Alaska, from 1990 to 2008. For the period of 2000 to 2012, trends (annual rates of change expressed as percent yr^{-1} with a 95% CI) in counts of the western stock of Alaska Steller sea lion non-pups (adults and juveniles) were 1.67% yr^{-1} and 1.45% yr^{-1} for pups (Johnson and Fritz, 2014).

Two designated stocks of Steller sea lions may occur near Cook Inlet: the western DPS (WDPS), and (78 *FR* 66139, November 4, 2013) eastern DPS (EDPS). A strong separation between the western and eastern stocks has been confirmed by numerous genetic analyses (Baker et al., 2005; Harlin-Cognato et al., 2006; Hoffman et al., 2006, 2009; O'Corry-Crowe, Taylor, and Gelatt, 2006). Management boundaries for these DPSs occur at 144ºW longitude (Cape Suckling, Alaska). Critical habitat has been designated south of the proposed Lease Sale Area in the Cook Inlet region (Figure 3.2.3-7). Refer to the Section 3.2.3.2.1, Steller Sea Lion Eastern Distinct Population Segment, for information on the EDPS.

Current Status and Critical Habitat

Steller sea lions, were listed under the ESA as threatened throughout their range on November 26, 1990 (55 *FR* 49204, November 26, 1990). This listing included animals from Alaska to California, and those in Japan, and Russia. In 1997, NMFS recognized two DPSs of Steller sea lions based on genetic studies, and other information (62 *FR* 24345, May 5, 1997); a eastern DPS listed as threatened and a western DPS listed as endangered. On November 4, 2013, the eastern DPS was removed from the list of endangered species (78 *FR* 66139, November 4, 2013).

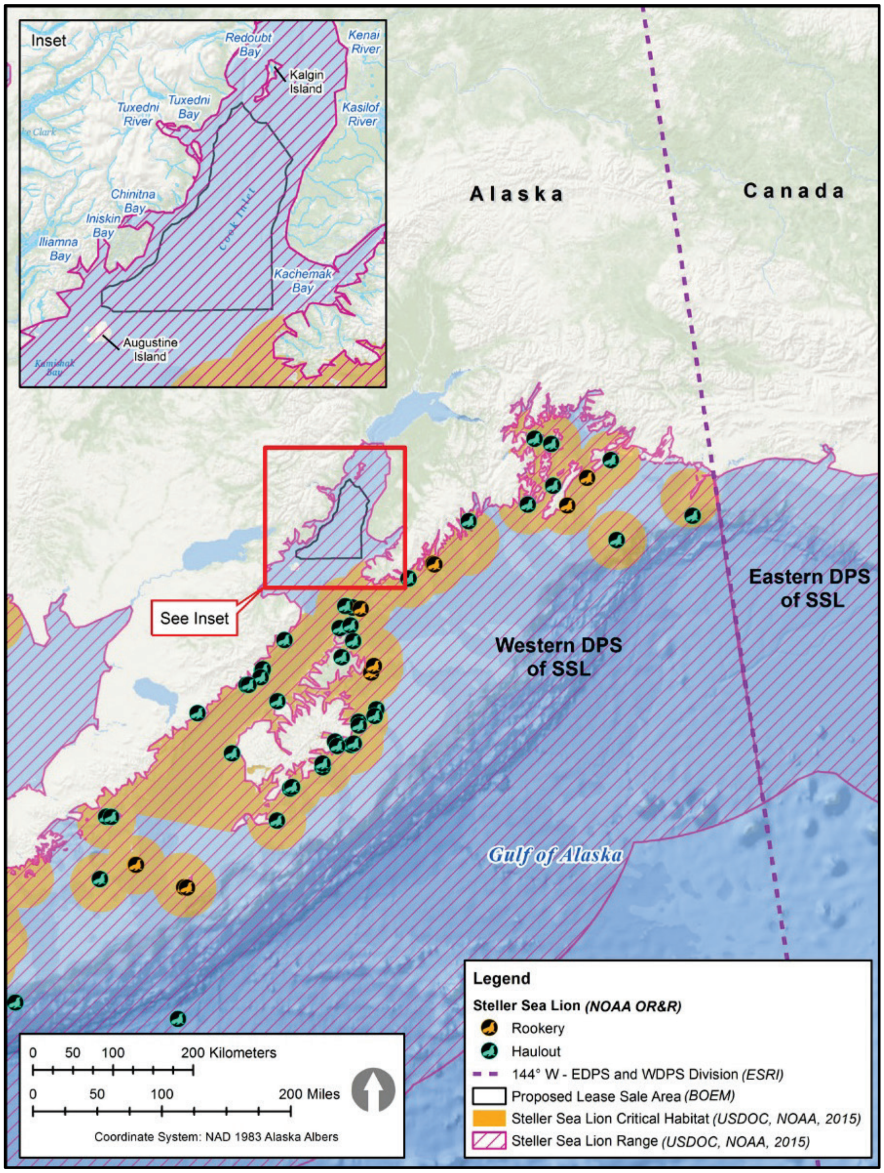


Figure 3.2.3-7. Steller Sea Lion Haul out and Rookery Sites. *(Western Distinct Population Segment (DPS) Critical Habitat, and Western and Eastern DPS Range in the Cook Inlet Region).*

Critical habitat for the Steller sea lion was designated on August 27, 1993 (58 *FR* 45269) based on information available at the time about rookery areas, haul outs, and marine areas required by the species for survival in the wild (Figure 3.2.3-7).The Critical habitat designation for the Western DPS of Steller sea lions was determined to include a 37 km (20 nmi) buffer around all major haul outs and rookeries, and associated terrestrial, atmospheric, and aquatic zones, plus three large offshore foraging areas (50 CFR 226.202 on August 27, 1993) (Figure 3.2.3-7). NMFS also designated no-entry zones around rookeries (50 CFR 223.202).

Under the MMPA, all Steller sea lions remain classified as strategic stocks and continue to be designated as depleted (Allen and Angliss, 2015). A recovery plan was originally developed for Steller sea lions in 1992 (NMFS, 1992), and in 2008, a revised recovery plan, which discusses separate recovery actions for the threatened and endangered populations, was issued (NMFS, 2008b).

Current and Historical Habitat Associations and Distribution

The geographic center of their distribution is considered to be the Aleutian Islands and the Gulf of Alaska (Kenyon and Rice, 1961), although as the WDPS has declined, rookeries in the west became progressively smaller (NMFS, 2008b). The center of abundance for the species is considered to extend from Kenai to Kiska Island (NMFS, 2008b). Steller sea lion habitat includes terrestrial sites for breeding and pupping (rookeries), resting (haul outs), and marine foraging areas. Nearly all rookeries are at sites inaccessible to terrestrial predators on remote rocks, islands, and reefs.

Steller sea lions can travel considerable distances (Baba, Nitto, and Nitta, 2000). Most adult Steller sea lions inhabit rookeries during the breeding season (late May to early July) (Gisiner, 1985; Pitcher and Calkins, 1981); some juveniles and non-breeding adults occur at or near rookeries during the breeding season, but most are on haul outs. Adult males, in particular, may disperse widely after the breeding season and during fall and winter, many sea lions increase use of haul outs, especially terrestrial sites but also on sea ice in the Bering Sea (NMFS, 2008b).

Sea lions from the EDPS and WDPS sometimes cross the 144˚W longitudinal boundary line, and frequent movement cross-boundary movement occurs in individuals from in both populations, particularly juveniles (Raum-Suryan et al., 2002).

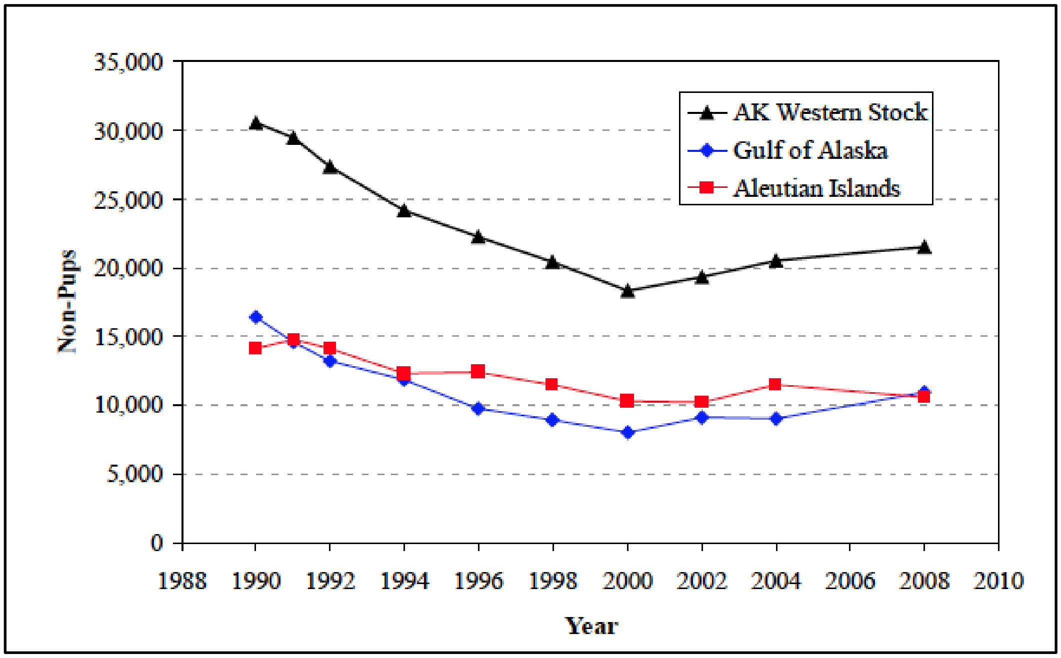


Figure 3.2.3-8. Adult and Juvenile Steller Sea Lions Rookery and Haul Out Trend Site Counts. *Trend site counts taken throughout the range of the Western U.S. Stock in Alaska, 1990 to 2008. Correction factor applied to 2004 and 2008 counts for film format differences (Fritz and Stinchcomb, 2005). Source: Allen and Angliss (2013).*

Foraging Ecology and Feeding

Steller sea lions feed on a variety of demersal, semi-demersal, and pelagic prey, indicative of a broad spectrum of foraging behaviors likely based primarily on prey availability (NMFS, 2008b). Inferences about sea lion foraging ecology are based on data collected by monitoring animals with telemetry devices, and a database detailing opportunistic sightings referred to as the Platforms of Opportunity (POP). Telemetry studies indicate that foraging trip duration and distance seasonally vary, but rarely exceed 20 hours and 20 km (12.4 mi) (AFSC, 2010; Fadely et al., 2005; Loughlin et al., 2003; Merrick and Loughlin, 1997; Raum-Suryan et al., 2004; Rehberg, 2005). Gregr and Trites (2008) determined that juvenile and female Steller sea lions particularly forage relatively close to rookeries and haul outs. These studies, and others, suggest two types of distribution at sea by Steller sea lions: 1) <20 km (12.4 mi) from rookeries and haul-out sites for adult females with pups, pups, and juveniles, and 2) >20 km (12.4 mi) areas where these and other animals may range to find optimal foraging conditions once they are no longer tied to rookeries and haul-out sites for nursing and reproduction (NMFS, 2010). The sites may provide crucial food sources while sea lions are far away from their rookeries and haul outs.

Scat analysis, added in 1990, showed that pollock continued to be a dominant prey species in the Gulf of Alaska, with Atka mackerel the most frequently occurring prey species in central and western Aleutian Island scats (Merrick et al., 1997; Sinclair and Zeppelin, 2002; NMFS, 2000). Pacific cod was found to be an important prey species, especially in winter in the Gulf of Alaska, with salmon most frequently eaten during summer months. NMFS (2000) compiled and assessed available data on prey occurrence from stomach analyses for the eastern and western Steller sea lion populations from the 1950s to 1980s. They found that for both populations, the occurrences of pollock, Pacific cod, and herring were higher in the 1980s than in the 1950s to 1970s.

Sources of Mortality

Subsistence hunting, and illegal killings are the primary anthropogenic sources of mortality for the Western DPS of Steller sea lions. In recent years up to 19 Steller sea lions have been reported as harvested in subsistence hunts. The mean average human-caused mortality and serious injury of eastern Steller sea lions for 2008-2012 from sources other than fisheries and Alaska Native harvest is 29.4 (Allen and Angliss, 2015).Between 2008 and 2012, there were incidental serious injuries and mortalities of western Steller sea lions observed in Alaska commercial fisheries. Reports from the NMFS stranding database of Steller sea lions entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality data. During the 5-year period from 2008 to 2012, there were six confirmed fishery-related Steller sea lion strandings in the range of the western stock (Allen and Angliss, 2014a). Alaska Natives actively subsist on Steller sea lions, however harvest numbers are no longer collected statewide, but rather, periodically in subareas. Data were collected on Alaska Native harvest of Steller sea lions for 7 communities on Kodiak Island for 2011; the Alaska Native Harbor Seal Commission and ADFG estimated a total of 20 adult sea lions were harvested, with a 95% confidence range between 15 to 28 animals (Wolfe, Hutchinson-Scarbrough, and Riedel, 2012).

Pups die by drowning, by starving after separation from their mother, as a result of disease, parasitism, predation, or being crushed by larger animals, by being bitten by other sea lions, and as a result of complications during parturition (Edie, 1977; Maniscalco, Atkinson, and Armato, 2002; Maniscalo, Parker, and Atkinson, 2006; Orr and Poulter, 1967; ADFG and NMFS, unpublished data as cited in NMFS, (2008b)). Mortality of older animals may be caused by starvation, injuries, disease, predation, subsistence harvests, intentional shooting by humans, entanglement in trash and debris, as a result of research-related mortalities, and by fishery interactions (Merrick, Loughlin, and Calkins, 1987; NMFS, 2008b).

Reports from the NMFS stranding database of Steller sea lions entangled in marine debris or with injuries caused by other types of human interaction are another source of mortality data. During the 5-year period from 2008 to 2012, 15 animals were observed with circumferential neck entanglements from packing bands or other unknown marine debris (Allen and Angliss, 2014a).

Northern Sea Otter (*Enhydra lutris kenyoni*), Southwest Alaska Stock – Threatened

Current and Historic Abundance

More than 90% of the world's sea otter population can be found in Alaskan waters (Rotterman and Simon-Jackson, 1988). The minimum population estimate for the Southwest Stock of northern sea otters is 45,064 (USFWS, 2014a). The NPS and USGS conducted aerial surveys of sea otters along the coastline of Katmai NPP in July 2012. The survey area ranged from Cape Douglas to the southwest end of Cape Kubugakli at the park's boundary. Preliminary results indicate a total estimated population size in 2012 of approximately 8,644 sea otters, with an overall density of 5.96 sea otters per km (USFWS, 2013b) (Table 3.2.3-3). The 2008 estimated population size in this area was 7,095 sea otters (Coletti et al., 2009), representing a 22% increase in population size from 2008 to 2012, suggesting immigration rather than birth rate contributed to the increase.

Current Status and Critical Habitat

Two distinct stocks of sea otters occur in the Cook Inlet region: the ESA-listed Southwest Stock, which is threatened, and the non-ESA listed Southcentral Stock. The Southcentral Stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai Peninsula coast, and eastern Cook Inlet; the Southwest Stock's range includes the west side of Cook Inlet, Alaska Peninsula and Bristol Bay coasts, and the Aleutian, Barren, Kodiak, and Pribilof Islands (USFWS, 2014a) (Figure 3.2.3-9).

Prior to 1995, the USFWS had generally managed sea otters in Alaska as a single population stock under the MMPA (Gorbics and Bodkin, 2001; USFWS, 1995, 65 *FR* 67343, November 9, 2000). Since then, NMFS has identified three sea otter stocks in Alaska: (1) a southwestern Alaska stock, located from the west side of Cook Inlet through the Kodiak Archipelago, the Alaska Peninsula and the Aleutian Islands; (2) a southcentral stock ranging from Cape Yakataga to Cape Douglas including Prince William Sound and the coast of the Kenai Peninsula; and (3) a southeastern stock extending from Dixon Entrance to Cape Yakataga (Allen and Angliss, 2015; Gorbics and Bodkin, 2001; Marine Mammal Commission, 2000).

The Southwest stock of northern sea otters is listed as threatened under the ESA; the USFWS has concluded that the Southwest stock of sea otters have declined unexpectedly, significantly, and in some cases, precipitously, over a large portion of their range, with the leading hypothesis for this population loss being predation by killer whales (Estes et al., 1998). Critical habitat for the southwest Alaska DPS of the northern sea otter was designated in 2009 (74 *FR* 51988; October 8, 2009). The total area of the critical habitat is 15,164 km^2 (5,855 mi^2). The proposed Lease Sale Area includes 7 OCS lease blocks that overlap with the critical habitat (Figure 3.2.3-9). The areal extent of the sea otter critical habitat within the proposed Lease Sale Area represents approximately 0.23% of the total area of the northern sea otter critical habitat.

Current and Historical Habitat Associations and Distribution

Sea otters generally are typified as inhabiting nearshore waters <35 m (115 ft) deep (Garshelis, 1987) and rarely range beyond the 55-m (180-ft) depth contour (Kenyon, 1969; Garshelis, 1987). Sea otters are year-round residents within the proposed Lease Sale Area, including nearshore areas in parts of western and eastern lower Cook Inlet and associated bays, the Kodiak Archipelago, the Kenai

Peninsula, and the Alaska Peninsula. Although the Southcentral stock is not listed under the ESA, life history information is presented in this section due to the similarity in animals between the two stocks.

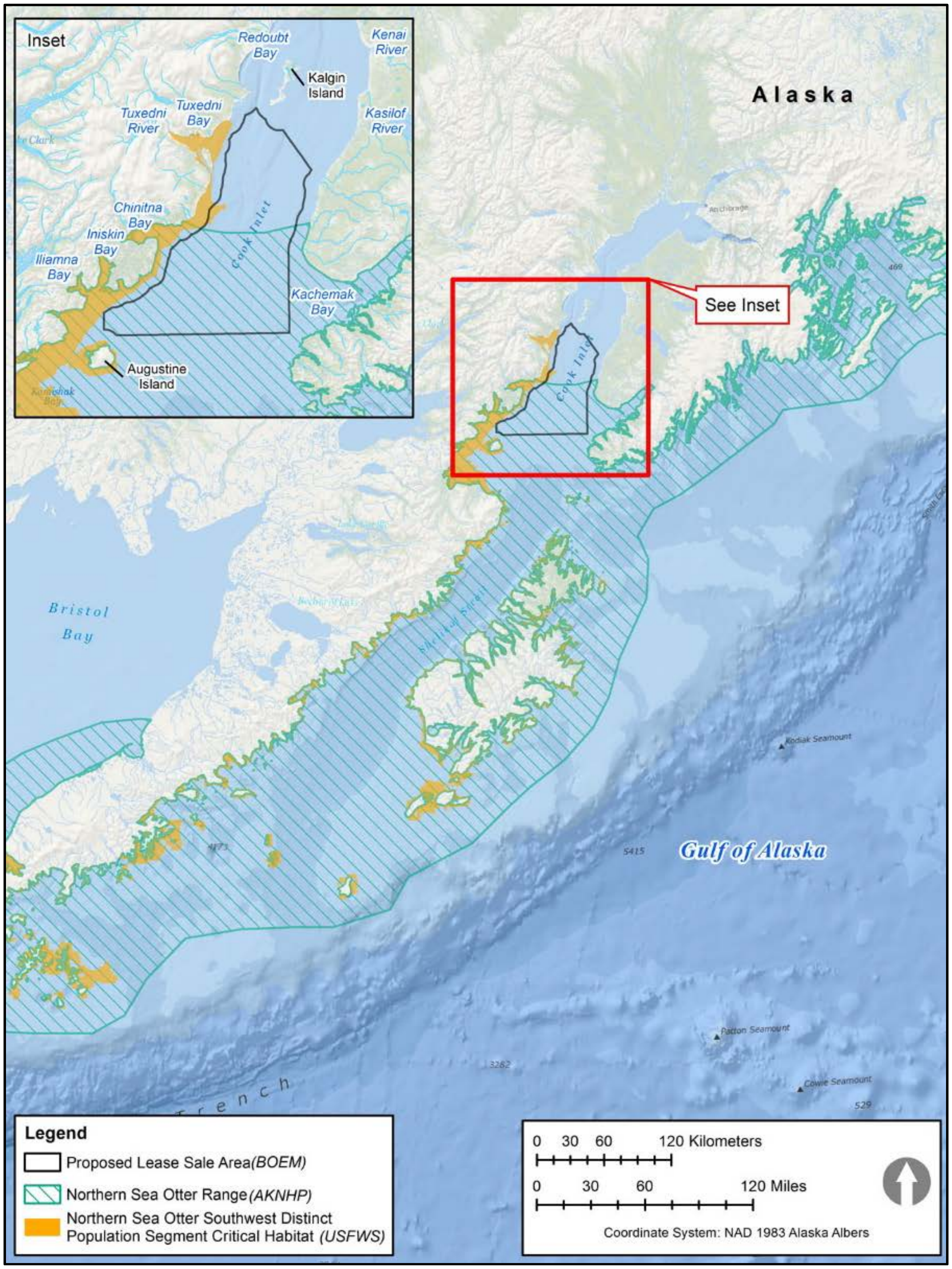


Figure 3.2.3-9. Range of Northern Sea Otters and Southwest Stock Critical Habitat.

Sea otters generally spend their entire lives in the water. During summer, sea otters have been observed predominantly using areas within 40 m of shore, as that is where most potential foraging opportunities occur (Bodkin, Monson, and Esslinger, 2003; Riedman and Estes, 1990; Schneider, 1976). Otters also may occur in offshore areas, often rafting together while transiting through these more open waters (Schneider, 1976). Deep, wide channels with strong current can act as barriers to sea otter movements but not usually an impenetrable one, greatly reducing, but not eliminating, movement of sea otters across such a channel.

Individual sea otters are capable of longer distance movements of >100 km (62 mi) (Garshelis and Garshelis, 1984); however, movements of animals likely are limited by geographic barriers, high energy requirements, and social behavior (Reidman and Estes, 1990). The extent of movement in sea otters varies with age, sex, reproductive status, and season (Monnett, 1988). Sea otters typically do not migrate and often travel within a territory <40 km^2 (15.44 mile^2) (Schneider and Ballachey, 2008). Males and females can make long movements, traveling between sites used seasonally (Garshelis and Garshelis, 1984; Monnett, 1988). At least in some Alaskan areas, females use different areas of their total home range in different seasons, depending on their reproductive status (whether or not they are accompanied by a pup, and the age of their pup) (Monnett, 1988). Males have been shown to have this same seasonal home range differentiation (Hoyt et al., 2015).

Table 3.2.3-3. Counts or Estimates of Southwest Alaska Stock Sea Otters near the proposed Lease Sale Area.

General Region	Year	Population Count
Kamishak Bay[2]	2002	6,918
Cape Douglas to Cape Kubugakli[3]	2012	8,644
Kodiak Archipelago[1]	2004	11,005

Source: [1]Bodkin, Monson, and Esslinger, (2003); [2]Bodkin, Esslinger, and Monson(2004); [3]USFWS (2013b).

In the Kodiak Archipelago, at least two remnant sea otter colonies may have survived, one north of Shuyak Island, and another at the southern end of Kodiak Island. An aerial survey of the Kodiak Archipelago conducted in 2004 resulted in an estimate of 11,005 sea otters (USFWS, 2014a). The subpopulation continues to expand throughout the area and based on model prediction is currently estimated at 13,200 sea otters (USFWS, 2014a). No offshore transects were flown in the Shelikof Strait area (Burn, 2002) and thus, there is no information available about offshore abundance or distribution of sea otters in the Shelikof Strait region. Table 3.2.3-3 summarizes the latest available sea otter population data for areas in the Cook Inlet region.

Foraging Ecology and Feeding

Sea otters forage in the nearshore benthos of rocky and soft-sediment communities. They typically forage close to shore in waters <25 to 40 m (82 to 131 ft) in depth (Estes, 1980; VanBlaricom and Estes, 1988). Due to their benthic foraging, sea otter distribution is largely limited by their ability to dive to the sea floor (Bodkin, Esslinger, and Monson, 2004).

Sea otters dive to gather food from the seafloor in relatively shallow water in areas with rocky substrates and soft bottom sediments (Riedman and Estes, 1990; USFWS, 2005a). Sea urchins, crabs, clams, mussels, octopuses, other marine invertebrates, and fish make up the diet of sea otters. Diving depth of sea otters is highly variable and ranges from 2 to 75 m (5 to 250 ft) depending on the prey species (Schneider and Ballachey, 2008). They usually dive and return with several items of food, roll on their backs, place the food on their chests and eat it piece by piece using their forepaws, with sometimes a rock to crack shells. In the wild, sea otters never eat on land. Feeding dives generally last about 1 to 1½ minutes, although some otters are capable of staying underwater for five minutes or more (Riedman and Estes, 1990).

Esslinger et al. (2014) indicated that of the sea otters sampled, most spent less time foraging during summer (females 8.8 hours/day, males 7.9 hours/day) than other seasons (females 10.1 to 10.5 hours per day, males 9.2 to 9.5 hours per day). Both sexes showed strong preferences for diurnal foraging and adjusted their foraging effort in response to the amount of available daylight. One exception to this diurnal foraging mode occurred after females gave birth. For approximately three weeks postpartum, females switched to nocturnal foraging, possibly in an effort to reduce the risk of predation by eagles on newborn pups (Esslinger et al., 2014).

Sources of Mortality

With the exception of starvation following overpopulation relative to the available prey base, and starvation due to rapid and severe sea-ice formation, well-documented instances of rapid, high levels of mortality have been directly or indirectly caused by humans in Alaska (e.g., deaths associated with past oil spills; the fur trade; and from other human-related causes). The 1989 Exxon Valdez Oil Spill dramatically demonstrated the effects of oil contamination on sea otters, and about 1,000 carcasses were found after the spill, while it is likely that the total number of dead was considerably greater (USFWS, 2005a).Other potential causes of mortality include predation (Estes et al., 1998; Gelatt, 1996), loss as fisheries bycatch (Hatfield et al., 2011), disease (Carrasco et al., 2014; Goldstein et al., 2009), boat strike (V. Gill unpublished data), and exposure to environmental contaminants (Hart, Gill and Kannan, 2009). In Alaska, the Kodiak salmon set gill net fishery, the Cook Inlet salmon set gillnet fishery, the Prince William Sound drift gillnet fishery, and the Prince William Sound salmon set gillnet fishery are now listed because of sea otter bycatch issues (79 *FR* 50589, August 25th, 2014; Allen and Angliss, 2014a).

3.2.3.2. Non-ESA Listed Species

Thirteen species of non-ESA listed marine mammals may occur in the Cook Inlet region and are discussed in the following sections (Table 3.2.3-4).

Table 3.2.3-4. Non-ESA Listed Marine Mammal Species in the Cook Inlet Region.

Common Name	Scientific Name
Harbor seal	*Phoca vitulina richardii*
Northern fur seal	*Callorhinus ursinus*
Steller sea lion (EDPS)	*Eumetopias jubatus*
Minke whale	*Balaenoptera acutorostrata*
Gray whale	*Eschrichtius robustus*
Killer whale	*Orcinus orca*
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Dall’s porpoise	*Phocoenoides dalli*
Harbor porpoise	*Phocoena phocoena*
Northern sea otter (Southcentral Alaska stock)	*Enhydra lutris kenyoni*
Cuvier's beaked whale	*Ziphius cavirostris*
Baird's beaked whale	*Berardius bairdii*
Stejneger's beaked whale	*Mesoplodon stejnegeri*

3.2.3.2.1. Pinnipeds

Non-ESA pinniped species that may occur in the Cook Inlet region include the Pacific harbor seal, northern fur seal, and the EDPS Steller sea lion (Figure 3.2.3-10).

Steller Sea Lion (*Eumetopia jubatus*) – Eastern Distinct Population Segment

Readers are referred to Section 3.2.3.1.8 for general information regarding this species. Although some EDPS Steller sea lions cross the 144˚W longitudinal line, those individuals are believed to be few in number (Fritz et al., 2013; Allen and Angliss, 2015). Unlike the Western U.S. Stock of Steller sea lions, the Eastern U.S. Stock has increased throughout most of its breeding range (Allen and Angliss, 2015), and the current minimum population estimate for the eastern stock is 59,968 individuals, uncorrected for animals at sea (Allen and Angliss, 2015).

Northern Fur Seal (*Callorhinus ursinus*) – Eastern Pacific Stock

The northern fur seal population that breeds in Alaska, primarily on the Pribilof Islands in the Bering Sea, ranges from the Bering Sea and Aleutian Islands eastward through the Gulf of Alaska and southward to California (Allen and Angliss, 2015). The Pribilof Islands Stock of northern fur seals was listed as depleted in 1988. Though this stock does not overlap with the proposed Lease Sale Area, they do occur in the Gulf of Alaska, and could potentially be contacted by released hydrocarbons in the event of a spill. Generally the Eastern Pacific Stock of fur seals ranges from the southern Bering Sea to Cook Inlet, in open ocean areas down to the continental shelf break.

After the1911 treaty between Russian and the US prohibiting pelagic sealing practices and reducing the take of seals on land, after the killing of females in the pelagic fur seal harvest was terminated in 1968 (Ferrero et al., 2000) and the Alaskan subset of the Eastern Pacific Stock of northern fur seals recovered to approximately 1.25 million by 1974,. The population then began to decrease with pup production declining at a rate of 6.5 to 7.8% per year into the 1980s (York, 1987). By 1983 the total stock estimate was 877,000 (Briggs and Fowler, 1984). The northern fur seal was designated as depleted under the MMPA in 1988 because population levels had declined to <50% of the level observed in the late 1950s, with no compelling evidence populations had increased since the late 1950s (NMML, 1993). The intentional killing of northern fur seals by commercial fishermen, sport fishermen, and others has also occurred. Mortality resulting from entanglement in trash and debris has been implicated as a contributing factor in the decline of the northern fur seal population in the northern Bering Sea (Ferrero et al., 2000). Under the MMPA, this stock remains listed as depleted until population levels rise above optimum sustainable population estimates (equal to 60% of carrying capacity) (Ferrero et al., 2000). The current minimum population estimate of the Eastern Pacific Stock of northern fur seals is 584,919 (Allen and Angliss, 2015).

Northern fur seals are highly migratory, and generally are found in nearly all months of the year throughout their range (Figure 3.2.3-10). The northward migration of individuals wintering in southern parts of the range begins in March and, from April to mid-June, large numbers are found in Gulf of Alaska waters (Consiglieri et al., 1982). By April the seal migration reaches the vicinity of Kodiak Island and during the summer months, after adult females and males have migrated through the Aleutians and into the Bering Sea, the majority of fur seals remaining around Kodiak Island are non-breeding individuals. Southward migration from the Pribilof Islands begins in October; by December, seals appear off southeast Alaska (Allen and Angliss, 2015). Several range boundaries of the northern fur seal are proposed; one that extends into lower Cook Inlet, intersecting the lower portion of the proposed Lease Sale Area (ADFG, 2015a; GIS data obtained from http://alaskafisheries.noaa.gov/arcgis), and another not reaching north of Kodiak Island or into the Kenai Peninsula (NMML, 1993). For the purpose of this Draft EIS, we are assuming that because the northern fur seal is a highly migratory species, there are instances when they could be found in waters of the Cook Inlet region. In general, the majority of northern fur seal sightings in the Gulf of Alaska occur south of Kodiak Island (Harry and Hartley (1981), as cited by NMML, 1993).

Although they lead a pelagic existence when they are not breeding, northern fur seals temporarily haul out on land at nonbreeding sites in Alaska, British Columbia, and the continental U.S. (Loughlin, 1993). Most adults are on land between June and October, defending their territories, giving birth, mating and rearing pups, then they spend the rest of the year at sea feeding (NMML, 1993). Their distributions in the Gulf of Alaska and throughout their winter range tend to be along the shelf break and offshore of the shelf break to beyond 100 km (62 mi) from shore (Bonnell, Bowlby, and Green, 1992; Fiscus, 1982). Adult males are typically onshore during a 4-month period from May to August, although they may be present all year round. Adult females are found ashore for as long as 6 months from June to November. Following their respective times ashore, seals of both genders migrate south and spend the next 7 to 8 months at sea (Roppel, 1984). Most adult males overwinter in Alaskan waters, while most females and immature males winter in waters off British Columbia, and the U.S. West Coast (Kajimura et al., 1980).

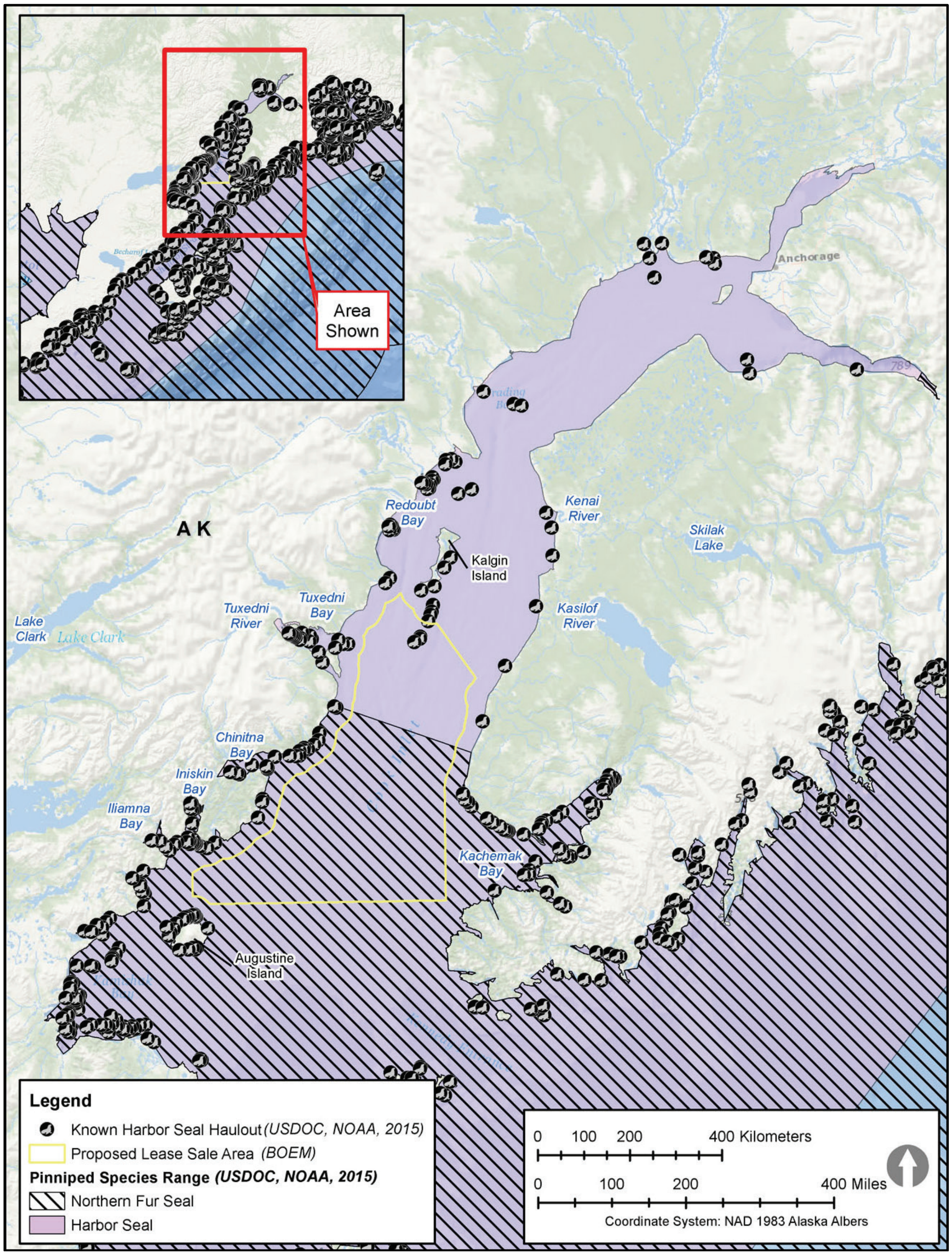


Figure 3.2.3-10. Non-ESA Listed Pinnipeds. *(Harbor Seal and Northern Fur Seal) Range map and Harbor Seal Haul out Locations in the Cook Inlet Region. (Source: NOAA, 2015b).*

Fur seals tend to congregate in areas over the outer continental shelf and slope where nutrient upwelling results in an abundance of various schooling fishes such as capelin, sand lance, pollock, and herring, and invertebrates such as squid, upon which the seals feed (Lowry, Frost, and Loughlin, 1989; Perez and Bigg, 1986). A shift in the abundance of fish in the Gulf of Alaska and eastern Bering Sea over the past several decades has caused changes in northern fur seal feeding patterns

(NMML, 1993). Entanglement in fishing gear, trash and debris, disease, subsistence harvest, and predation are sources of mortality for the northern fur seal (NMML, 1993).

Harbor Seal (*Phoca vitulina richardii*)

Harbor seals occupy a wide variety of habitats in freshwater and saltwater in protected and exposed coastlines. Harbor seals are found throughout the entire lower Cook Inlet coastline, hauling out on beaches, islands, mudflats, and at the mouths of rivers in the Cook Inlet where they whelp and feed (USACE, 2011). Harbor seals are common in Alaskan waters with statewide abundance estimates at 152,602 animals (Allen and Angliss, 2015), (Figure 3.2.3-10), and they are not listed as “depleted” under the MMPA.

In 2010, NMFS and their co-management partners, the Alaska Native Harbor Seal Commission, defined 12 separate stocks of harbor seals based largely on genetics. The harbor seal stocks present in or near the proposed Lease Sale Area include the Cook Inlet/Shelikof Stock, the South Kodiak Island Stock, the North Kodiak Island Stock, and the Prince William Sound Stock. Current population abundance estimates for harbor seals stocks in or near the proposed Lease Sale Area are shown in Table 3.2.3-5 (Allen and Angliss, 2015).

Table 3.2.3-5. Counts or Estimates of Harbor Seals from Stocks in the Cook Inlet Region.

Stock	Last Year of Survey	Abundance Estimate	Minimum Population Estimate
Cook Inlet/Shelikof	2006	22,900	21,896
North Kodiak Island	2006	4,509	4,272
South Kodiak Island	2006	11,117	10,645
Prince William Sound	2006	31,503	27,157

Source: Allen and Angliss, 2015

Information on stock population trends if available are discussed below. All text related to stock populations draws from Allen and Angliss (2015).

Cook Inlet/Shelikof: A multi-year study of seasonal movements and abundance of harbor seals in Cook Inlet was conducted between 2004 and 2007. This study involved multiple aerial surveys throughout the year, and data from this study indicate a stable population of harbor seals during the August molting period (Montgomery, Ver Hoef, and Boveng, 2007). Aerial surveys along the Alaska Peninsula present greater logistical challenges and therefore have been conducted less frequently. The current population trend for the entire stock is unknown.

North Kodiak: Population trend information for the North Kodiak Stock is not available.

South Kodiak: A significant portion of the harbor seal population within the South Kodiak Stock is located at and around Tugidak Island off the southwest of Kodiak Island. Sharp declines in the number of seals present on Tugidak were observed between 1976 and 1998. The highest rate of decline was 21% per year between 1976 and 1979 (Pitcher, 1990). While the number of seals on Tugidak has stabilized and shows some evidence of increase since the decline, the population in 2000 remained reduced by 80% compared to the levels in the 1970s (Jemison et al., 2006). The current population trend for this stock is unknown.

Prince William Sound: The Prince William Sound Stock includes harbor seals both within and adjacent to Prince William Sound. Within Prince William Sound proper, harbor seals declined in abundance by 63% between 1984 and 1997 (Frost, Lowry, and Ver Hoef, 1999). More recent analysis of population abundance (ADFG, unpublished) and trend within Prince William Sound proper indicates the population stabilized around 2002 and likely has been increasing since then. Trend information and analysis for the entire Prince William Sound Stock is not available at this time.

Seals are more likely to be hauled out during the pupping and breeding period, and haul out less frequently during late fall and winter (Boveng, London, and Ver Hoef, 2012). Their summer distribution in the proposed Lease Sale Area is primarily along coastal waters of Cook Inlet; overwinter areas include the lower half of Cook Inlet and the Gulf of Alaska (Boveng et al., 2007). The harbor seal hauls out, gives birth, and nurses its young on land. Harbor seals prefer to haul out on tidally exposed habitats including reefs, offshore rocks and islets, mud and sand, sand and gravel beaches, and floating and shorefast ice (Bigg, 1981; Pitcher and Calkins, 1977).

Generally non-migratory, their local movements are associated with seeking food and breeding (Biggs, 1981). Harbor seals are opportunistic feeders whose diet varies with season and location. Harbor seals feed in marine, estuarine, and occasionally freshwater habitats (Ferrero et al., 2000). In the Gulf of Alaska, Pitcher and Calkins (1979) found that fish, pollock and capelin comprised 74.3% of total prey volume; cephalopods, 21.7%; and decapod crustaceans, 4.0%. Scat analysis from seals at Kodiak Island show Irish lords (*Hemilepidotus hemilepidotus)* (43%) and sand lances (family *Ammodytidae)* (25%) were predominate prey items (Jemison, 2001).

In Cook Inlet, seal use of western habitats is greater than use of the eastern coastline (Boveng, London, and Ver Hoef, 2012). NOAA has documented a strong seasonal pattern of more coastal and restricted spatial use during the spring and summer for breeding, pupping, and molting, and more wide-ranging seal movements within and outside of Cook Inlet during the winter months (Boveng, London, and Ver Hoef, 2012). Large-scale patterns indicate a portion of harbor seals captured in Cook Inlet move out of the area in the fall, and into habitats within Shelikof Strait, Northern Kodiak Island, and coastal habitats of the Alaska Peninsula, and are most concentrated in Kachemak Bay, across Cook Inlet toward Iniskin and Iliamna Bays, and south through the Kamishak Bay, Cape Douglas and Shelikof Strait regions (Boveng, London, and Ver Hoef, 2012). A portion of the Cook Inlet seals move into the Gulf of Alaska and Shelikof Strait during the winter months (London et al., 2012). As the seals approach breeding in April and May, the seals move back into Cook Inlet and their spatial use is more concentrated around haul-out areas (Boveng, London, and Ver Hoef, 2012; London et al., 2012). Some seals expand their use of the northern portion of Cook Inlet, however, in general, seals that were captured and tracked in the southern portion of Cook Inlet remained south of the Forelands (Boveng, London, and Ver Hoef, 2012). Important harbor seal haul-out areas occur within Kamishak and Kachemak Bays and along the coast of the Kodiak Archipelago and the Alaska Peninsula. Chinitna Bay, Clearwater and Chinitna Creeks, Tuxedni Bay, Kamishak Bay, Oil Bay, Pomeroy and Iniskin Islands, and Augustine Island are also important spring-summer breeding and molting areas and known haul-outs sites (Figure 3.2.3-10). Small-scale patterns of movement within Cook Inlet also occur (Boveng, London, and Ver Hoef, 2012).

The Cook Inlet/Shelikof Stock is distributed from Anchorage into lower Cook Inlet during summer, and from lower Cook Inlet through Shelikof Strait to Unimak Pass during winter (Boveng, London, and Ver Hoef, 2012). Large numbers concentrate at the river mouths and embayments of lower Cook Inlet, including the Fox River mouth in Kachemak Bay, and several haul outs have been identified on the southern end of Kalgin Island in lower Cook Inlet (Rugh et al., 2005; Boveng, London, and Ver Hoef, 2012). Montgomery, Ver Hoef, and Boveng (2007) recorded over 200 haul-out sites in lower Cook Inlet alone. Large aggregations of harbor seals have been observed hauled out at the mouths of the Theodore and Lewis Rivers during seismic monitoring programs (NMFS 2015b).

3.2.3.2.2. Fissipeds

Northern Sea Otter (*Enhydra lutris kenyoni*) – Southcentral Alaska Stock

The Southcentral Alaska Stock of northern sea otters extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai Peninsula coast, and Kachemak Bay (USFWS, 2014b), and does not typically occur in upper Cook Inlet (USFWS, 2014b; Angliss and Outlaw, 2008).They generally occur at low densities except at Kachemak and Kamishak Bays (Gill, Doroff and Burn, 2009). The minimum modeled population estimate for the Southcentral Alaska Stock of northern sea otters is 14,661 individuals (USFWS 2014b). Table 3.2.3-6 provides the latest stock assessment report results. The overall trend for the Southcentral Alaska Stock appears to be stable or slightly increasing, and the population in lower Cook Inlet and Kenai Fjords also appears to be increasing slightly (Coletti et al., 2009; Estes et al., 2010; USFWS, 2013b; USGS unpublished data as cited in USFWS, 2014b). Much of the information presented on the southwest sea otter DPS (i.e. their life history) applies to the southcentral sea otter DPS, and readers are referred to Section 3.2.3.1.9 for general information regarding the species. The range of the Southcentral DPS of the northern sea otter is shown in Figure 3.2.3-9.

Table 3.2.3-6. Counts of Sea Otters in the Southcentral Alaska Stock in the Cook Inlet Region.

General Region	Year	Population Count (adjusted estimate)
North Gulf of Alaska[1]	2000	428
Cook Inlet/Kenai Fjords[2]	2002	2,673
Prince William Sound[2]	2003	11,989

Source: [1]USGS Unpublished Data cited in Allen and Angliss, 2015, [2]Bodkin, Monson, and Esslinger (2003).

3.2.3.2.3. Cetaceans

Non-ESA listed cetaceans likely to occur in the Action Area are the gray whale, killer whale, Dall’s porpoise, minke whale, and harbor porpoise. Non-ESA listed cetaceans uncommon in the Cook Inlet region are the Cuvier's beaked whale, Baird's beaked whale, Stejneger's beaked whale, Dall’s porpoise, and the Pacific white-sided dolphin. Comparatively brief discussions are included for uncommon species, relative to those species more commonly found in Cook Inlet.

Minke Whale (*Balaenoptera acutorostrata*)

Minke whales are the smallest species of baleen whales, reaching lengths of up to 11 m (35 ft). They feed on a variety of small schooling fish and euphausiids by using lung-feeding or bird-associated feeding strategies (Nemoto, (1959) as cited by Consiglieri et al., 1982; Hoelzel et al., 1989; Horwood, 1990). Minke whales are most abundant in the Gulf of Alaska during summer, where some become more sedentary, with individuals seasonally occupying localized feeding ranges (Dorsey, 1981). Concentrations of minke whales have occurred along the north coast of Kodiak Island (and along the south coast of the Alaska Peninsula (Zerbini et al., 2006). Prior to 2006, there were no estimates of the number of minke whales in Alaska (Ferrero et al., 2000), however, some information is now available for some areas of Alaska. A line-transect survey was conducted in shelf and nearshore waters from 2001 to 2003 from the Kenai Fjords in the Gulf of Alaska to the central Aleutian Islands (Allen and Angliss, 2015). The current estimate for minkes between Kenai Fjords and the Aleutian Islands is 1,233 individuals (Zerbini et al., 2006). During shipboard surveys conducted in 2003, three minke whale sightings were made, all near the eastern extent of the survey from nearshore Prince William Sound to the shelf break (NMML, 2003). Such estimates cannot be used as an estimate of the entire Alaska stock of minke whales because only a portion of the stock’s range was surveyed at any given time (Allen and Angliss, 2015).

Figure 3.2.3-11 displays the minke whale range. Minke whales become scarce in the Gulf of Alaska in fall; most whales probably leave the region by October (Consiglieri et al., 1982). Minke whales are migratory in Alaska, but recently have been observed off Cape Starichkof and Anchor Point year-round (Allen and Angliss, 2013). Minke whales have been sighted off the coast of Anchor Point during winter months, during aerial surveys, and during exploration activities (USDOI, BOEM, 2015d). As such, minke whales may occur in the proposed Lease Sale Area as far north as lower Cook Inlet. More information on minke whale range can be found on the NOAA Marine Mammal Stock Assessment Reports website: http://www.nmfs.noaa.gov/pr/sars/species.htm.

Killer Whale (*Orcinus orca*)

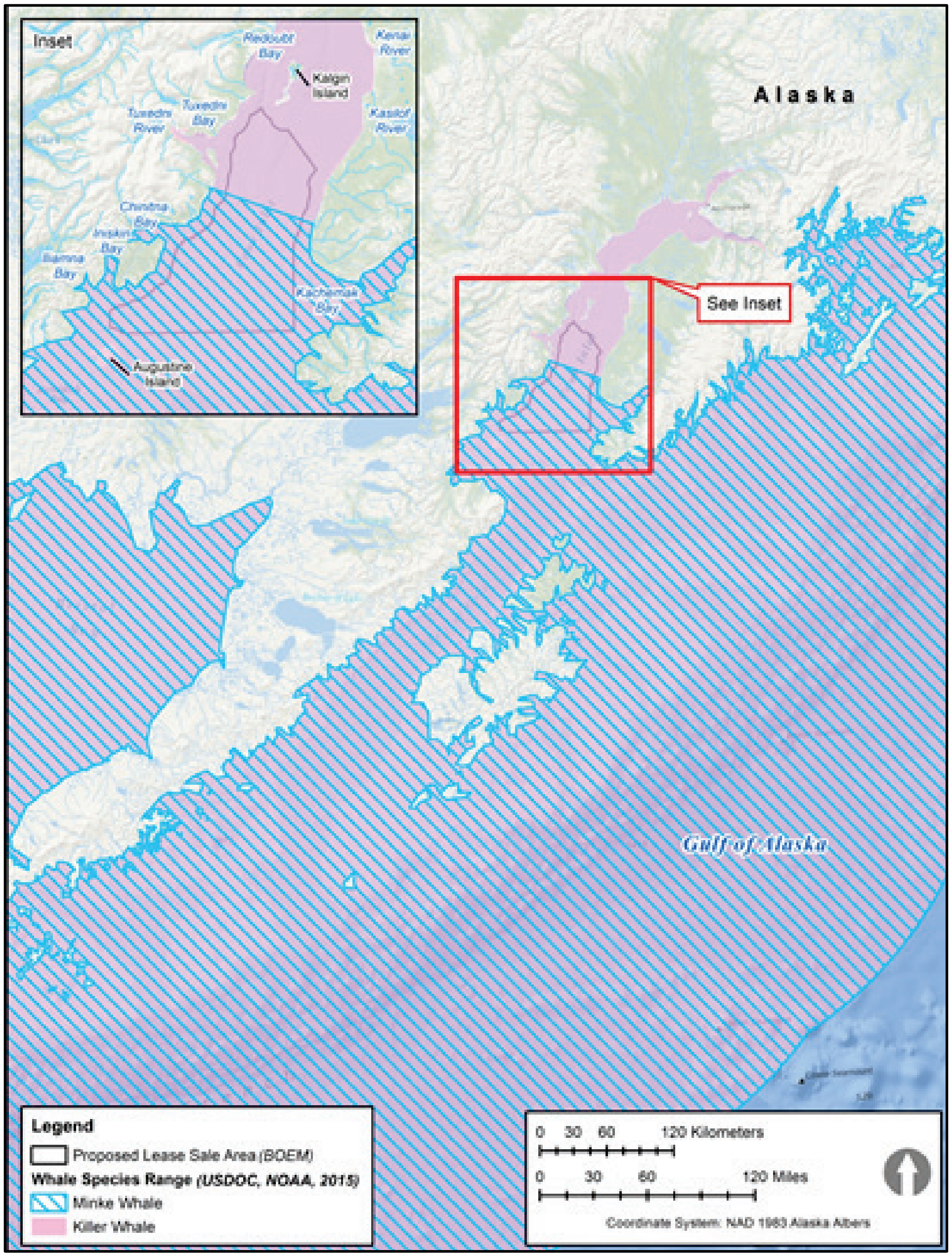


Figure 3.2.3-11. Minke and Killer Whale Species Range map in the Cook Inlet Region. (NOAA, 2015b).

Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim, 1982), where whales have been labeled as 'resident,' 'transient,' and 'offshore' type killer whales (Bigg, 1990; Dahlheim et al., 2008; Ford, Ellis, and Balcomb, 2000). Several studies provide evidence that the 'resident', 'offshore', and 'transient' ecotypes are genetically distinct in mtDNA and nuclear DNA (Barrett-Lennard, 2000; Hoelzel and Dover, 1991; Hoelzel, Dalheim, and Stern, 1998, Hoelzel et al., 2002). The killer whales using Cook Inlet are thought to be a mix of resident and transient individuals from two different stocks: the Alaska Resident Stock, and the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock (Allen and Angliss, 2015). The population estimate for the Alaska Resident Stock is estimated at 2,347 individuals, with a minimum population estimate of 2,084 (Allen and Angliss, 2015). Though no official abundance estimate exists for this stock because of incomplete surveys of the stocks range, a minimum population estimate for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock was estimated to be 587 (Allen and Angliss, 2015).

In spring, killer whales are found throughout the Gulf of Alaska in shallow waters <200 m (656 ft) deep (Braham and Dahlheim, 1982). In summer, they are apparently more concentrated in the Kodiak Island area (Braham and Dahlheim, 1982). The movement of resident killer whales in nearshore waters, especially in summer and fall is in part related to inshore migrations of pelagic fish, such as salmon and other shoaling fish, which are common prey species in these areas (Balcomb et al., 1980; Heimlich-Boran, 1988). Resident whales feed exclusively on fish and are genetically distinct from transient whales (Saulitis et al., 2000). Transient whales feed primarily on marine mammals (Saulitis et al., 2000) such as such as seals, porpoises, dolphins, and beluga, sperm, and baleen whales (Barr and Barr, 1972; Dahlheim et al., 1994; Heimlich-Boran, 1988; Hancock, 1965; Pitman et al., 2001).

Most of the confirmed sightings of killer whales in Cook Inlet were located in the lower inlet area (USACE, 2011), especially near Homer and Port Graham (Rugh et al., 2005; Shelden et al., 2003)(Figure 3.2.3-11). The few whales that have been photographically identified in lower Cook Inlet belong to resident groups more commonly found in nearby Kenai Fjords and Prince William Sound (Shelden et al., 2003). During aerial surveys conducted between 1993 and 2004, killer whales were observed on three flights, all in the Kachemak and English Bay area (Rugh et al., 2005). However, anecdotal reports of killer whales feeding on belugas in upper Cook Inlet began increasing in the 1990s, possibly in response to declines in sea lion and harbor seal prey elsewhere (Shelden et al., 2003). These sporadic ventures of transient whales into beluga summering grounds have been implicated as a possible contributor to the decline of Cook Inlet beluga in the 1990s, although the number of confirmed mortalities from killer whales is small (Shelden et al., 2003). The Cook Inlet Beluga Whale Recovery Plan summarized killer whale observations and reports of killer whale predation from 1982 to 2014, mainly for upper Cook Inlet, and found 33 total sightings of killer whales: 29 in upper Cook Inlet, and 4 in mid-Cook Inlet to lower Cook Inlet (NMFS, 2015a).

Known natural mortality rates of killer whales are very low; mortality rates vary from 1 to 5% (Braham and Barlow, 1991). A single pod in Prince William Sound has suffered a higher mortality rate (7.4%), related to human interaction associated with the longline sable and black cod fishery (Leatherwood et al., 1990), and losses reflecting approximately 20% mortality occurred between 1989 and 1990 that may have been related to interactions with fisheries, or to the Exxon Valdez Oil Spill (Dahlheim and Matkin, 1994).

Gray Whale (*Eschrichtius robustus*) – Eastern North Pacific Stock

In spring, the Eastern North Pacific Stock of gray whales migrates approximately 8,000 km (5,000 mi) from wintering and calving areas around Baja California, Mexico to feeding grounds in the Bering and Chukchi Seas, before returning to their wintering areas in the fall (Rice and Wolman, 1971). Although gray whales primarily feed in the northern and western Bering and Chukchi Seas during the summer, whales also have been reported feeding near Kodiak Island, in southeastern Alaska, and south along the Pacific Northwest (Allen and Angliss, 2013) (Figure 3.2.3-12).

Some gray whales do not migrate completely from Baja to the Chukchi Sea but instead feed in select coastal areas in the Pacific Northwest, including lower Cook Inlet (Moore et al., 2007; Rice, Wolman, and Braham, 1984). Though most gray whales migrate past Cook Inlet, small numbers have been noted by fishers near Kachemak Bay, and north of Anchor Point (USDOI, BOEM, 2015d). Because the majority of gray whales migrating through the Gulf of Alaska region are thought to take a coastal route, BIA boundaries for the migratory corridor in this region were defined by the extent of the continental shelf (Figure 3.2.3-12) (Ferguson et al., 2015). The greatest densities of gray whales are found in this BIA from November through January, and March through May; the former are southbound, the latter are northbound (Ferguson et al., 2015). A Migratory Corridor BIA was defined as “areas and times within which a substantial portion of a species is known to migrate; the corridor is spatially restricted…” (Ferguson et al., 2015).

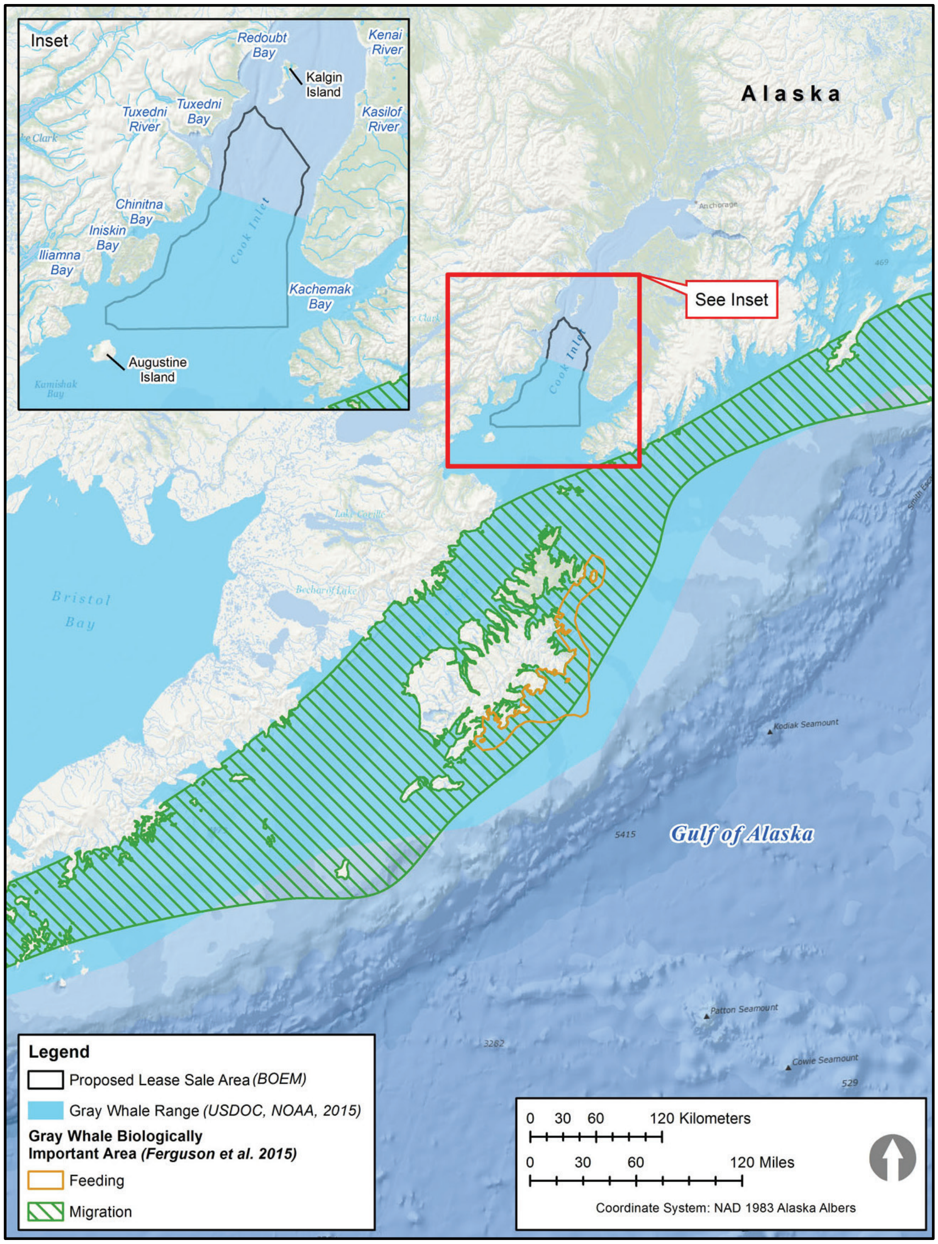


Figure 3.2.3-11 Gray Whale Species Range Map and Biologically Important Areas in the Cook Inlet Region. *Source: Ferguson et al. 2015; NOAA, 2015b.*

Based on regular occurrence of feeding gray whales including repeat sightings of individuals across years near the mouth of Ugak Bay on Kodiak Island, Ferguson et al. (2015) designated this area as a Feeding Area BIA (Figure 3.2.3-12). Feeding Area BIAs are defined as “areas and times within which aggregations of a particular species preferentially feed. These may be persistent in space and time or associated with ephemeral features that are less predictable but are located within a larger area that can be delineated…” (Ferguson et al., 2015).

Most gray whales calve and breed from late December to early February in protected waters along the western coast of Baja California, Mexico. Northward migration, primarily of individuals without calves, begins in February; some cow/calf pairs delay their departure from the calving area until well into April (Jones and Swartz, 1984). Gray whales approach the proposed Lease Sale Area in late March, April, May, and June, and leave again in November and December (Consiglieri et al., 1982; Rice and Wolman, 1971). Although there have been numerous sightings of gray whales in Shelikof Strait, most of the population follows the outer coast of the Kodiak Archipelago from the Kenai Peninsula in spring or the Alaska Peninsula in fall (Consiglieri et al., 1982; Rice and Wolman, 1971). Spring concentrations occur along eastern Afognak Island, and the northeastern, central, and southeastern Kodiak Island area during spring and fall migrations (Consiglieri et al., 1982; Rice and Wolman, 1971). Gray whale concentrations have been reported in Shelikof Strait, along the west side of Kodiak Island, during the fall (Consiglieri et al., 1982; Rice and Wolman, 1971). Due to an unusual mortality event in 1999-2001, the stock size was reduced to about 16,000 animals by 2002; however, it has grown since to an estimated size of 20,990 animals, with an estimated minimum of 20,125 (Carretta et al., 2015).

Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

In the eastern North Pacific the species occurs from the southern Gulf of California, north to the Gulf of Alaska, and west to Amchitka in the Aleutian Islands (Figure 3.2.3-13) (Allen and Angliss, 2015). Although the species range extends into the southern Bering Sea, they are rarely encountered in that region (Allen and Angliss, 2015). Two management stocks are recognized because of separate fishery interactions: 1) the California/Oregon/Washington Stock, and 2) the North Pacific Stock, which is the one that overlaps with the Action Area. The segment of the North Pacific stock occurring above 45^{o}N latitude in the Gulf of Alaska has an estimated abundance of 26,880 animals (Allen and Angliss, 2015). There is no minimum population estimate as the abundance estimate is more than eight years old (Allen and Angliss, 2015).

Species abundance is thought to be seasonally variable in the Gulf of Alaska, with rare presence in winter, becoming increasingly abundant in the spring (Morris, Alton, and Braham, 1983). In the Gulf of Alaska, they are most abundant in the summer when females are calving, and typically found concentrated in area of high fishing abundance and activity. They feed primarily on squid and small fish (capelin, sardines, and herring), and often hunt as a team to herd prey (USACE, 2011). During surveys conducted in 2003, the NMML conducted ship-based transect surveys for marine mammals in the Gulf of Alaska (NMML, 2003). Two schools of Pacific white-sided dolphins occurred just off the Kenai Peninsula near Resurrection Bay; this was nearest observation of the species to the proposed Lease Sale Area. Pacific white-sided dolphins are expected to occur more frequently in the lower Cook Inlet than the upper Cook Inlet, due to their prey and pelagic habitat distribution (NOAA, 2012).

Dall's Porpoise (*Phocoenoides dalli*)

Dall's porpoise are widely distributed throughout the North Pacific Ocean including Alaska (Allen and Angliss, 2015) preferring deep offshore and shelf-slopes, and deep oceanic waters (USDOI, BOEM, 2015d; Allen and Angliss, 2015). Dall's porpoises are present year-round throughout their entire range in the northeast including the Gulf of Alaska, and occasionally the Cook Inlet area (Morejohn, 1979). The Dall's porpoise range in Alaska extends into the southern portion of the proposed Lease Sale Area (Figure 3.2.3-13). There is a distribution gap of Dall's porpoise in the Cook Inlet area and the shallow eastern flats of the Bering Sea (Allen and Angliss, 2015). Concentrations of Dall's porpoises have been reported in Shelikof Strait and around Kodiak and Afognak Islands (Ferrero et al., 2000). This porpoise also has been observed in lower Cook Inlet, around Kachemak Bay, and rarely near Anchor Point (USDOI, BOEM, 2015d).

The abundance estimate for the Alaska Stock of Dall's porpoise is 417,000 animals (Allen and Angliss, 2015), making it one of the more abundant cetaceans in Alaskan waters. There is no minimum population estimate as the abundance estimate is more than eight years old (Allen and

Angliss, 2015). The porpoises usually travel in groups of 10 to 20 animals but larger groups of >200 individuals have been reported (Consiglieri et al., 1982; Leatherwood and Reeves, 1987). Dall's porpoise consume squid, crustaceans, and deepwater fish such as saury, hake, herring, and jack mackerel (Leatherwood and Reeves, 1987).

Harbor Porpoise (*Phocoena phocoena*)

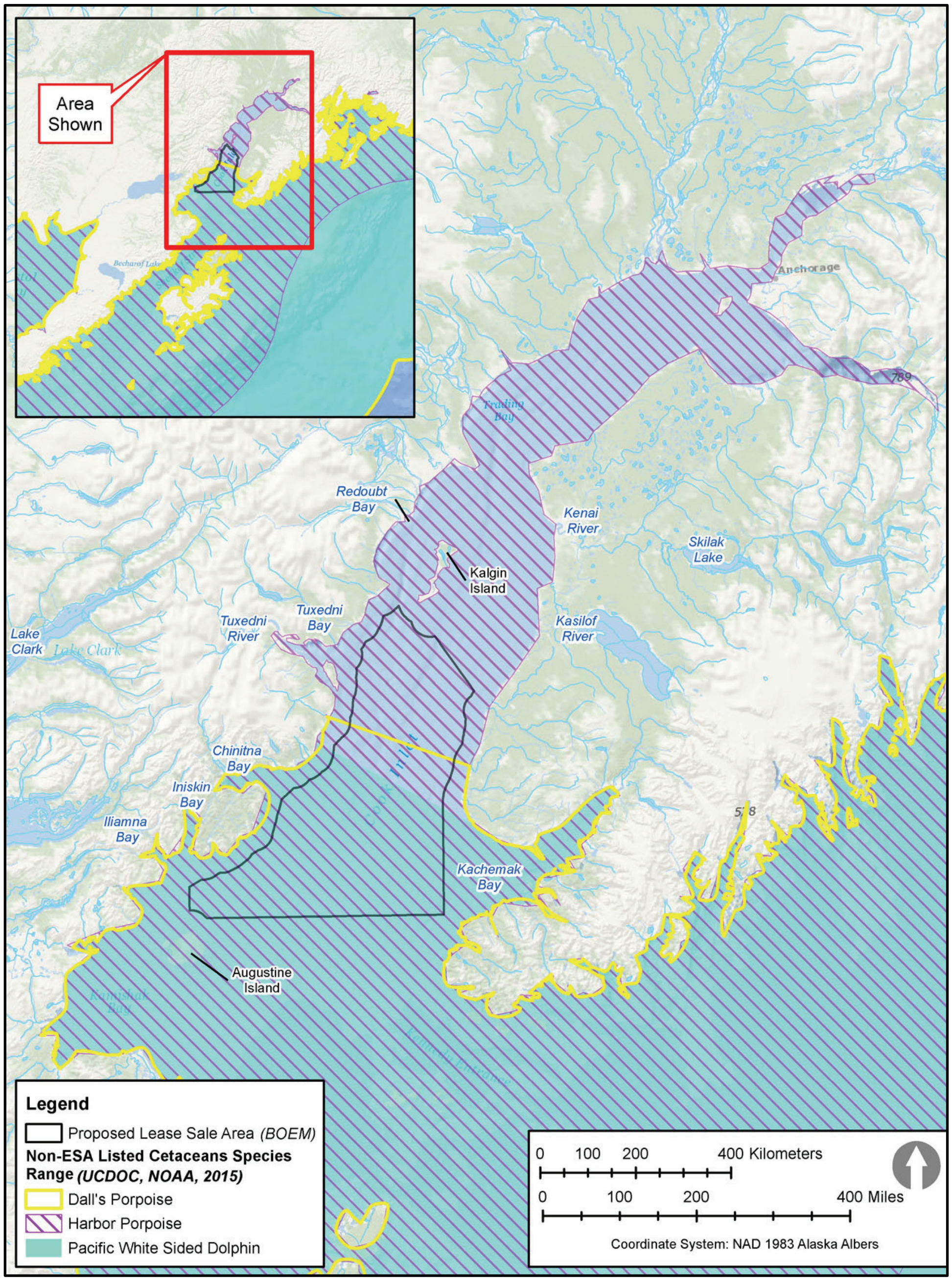


Figure 3.2.3-12. Dall's Porpoise, Harbor Porpoise, and Pacific White-Sided Dolphin Range Map. *Source: NOAA, 2015b.*

The range of the harbor porpoise includes the entire Cook Inlet, Shelikof Strait, and the Gulf of Alaska (Figure 3.2.3-13). In spring and summer, harbor porpoise sightings are numerous in the Kodiak Island area and Kachemak Bay (Hansen and Hubbard, 1999). Harbor porpoises have been observed in Cook Inlet and Shelikof Strait during winter months, indicating they are year-round residents in the region, although sightings are much less frequent in the fall and winter, compared to spring and summer (Hansen and Hubbard, 1999). Harbor porpoise move inshore in summer, and offshore in winter (Neave and Wright, 1969, as cited by Consiglieri et al., 1982). Decline in numbers of porpoises observed in Prince William Sound during winter months also suggests seasonal dispersion (Hall, 1979). Mating probably occurs from June or July to October, with peak calving in May and June (Tomilin (1957) as cited by Consiglieri et al., 1982). They are found primarily in coastal waters <100 m (328 ft) deep (Hobbs and Waite, 2010), where they feed on Pacific herring, other schooling fishes, and cephalopods, apparently preferring non-spiny, schooling fish such as herring, mackerel, and pollock (Leatherwood and Reeves, 1987). Foraging typically occurs in waters <200 m (656 ft) deep (Shelden et al., 2014). Harbor porpoise sightings in the upper inlet also appear to peak during ice-free months when there is an abundance of pelagic smelt (Shelden et al., 2014).

In Alaskan waters, three stocks of harbor porpoise are currently recognized for management purposes: Southeast Alaska, Gulf of Alaska, and Bering Sea Stocks (Allen and Angliss, 2015). Porpoises found in Cook Inlet belong to the Gulf of Alaska Stock which is distributed from Cape Suckling to Unimak Pass and most recently was estimated to number 31,046 individuals (Allen and Angliss, 2015). The Gulf of Alaska Stock of harbor porpoise appear to be widespread throughout the inlet, though occasionally, large aggregations are found in coastal and offshore waters of the lower inlet where they are much more common (Shelden et al., 2014). Harbor porpoise sightings are numerous in the Kodiak Island area, Kachemak Bay, Prince William Sound, Yakutat Bay, and southeast Alaska in the spring and summer (Hall, 1979). The harbor porpoise frequently has been observed during summer aerial surveys of Cook Inlet, with most sightings of individuals concentrated at Chinitna and Tuxedni Bays on the west side of lower Cook Inlet (Figure 3.2.3-10) (Rugh et al., 2005). They are one of the three marine mammals (the other two being belugas and harbor seals) regularly seen throughout Cook Inlet (Nemeth et al., 2007), especially during spring eulachon and summer salmon runs.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

The Cuvier’s beaked whale is uncommon in the Action Area (NOAA, 2015b; Appendix A Section A-1). Cuvier's beaked whales may have the most extensive range of any beaked whale species (Heyning, 1989; 2002). They are widely distributed in offshore waters of all oceans (Taylor et al., 2008a) (Figure 3.2.3-14). Cuvier's beaked whales, like all beaked whales, appear to prefer deep waters for feeding (Taylor et al., 2008a). Although few stomach contents have been examined, the whales are thought to feed opportunistically, mostly on cephalopods (e.g. squid and octopus) and sometimes fish and crustaceans (NMFS, 2012a). They likely feed near the bottom and in the water column using suction to draw prey items into their mouths at close range (Heyning and Mead (1996) as cited in Taylor et al., 2008).

For management purposes, Cuvier's beaked whales inhabiting U.S. waters have been divided into five stocks: the Alaska Stock, the California/Oregon/Washington Stock, the Hawaiian Stock, the Northern Gulf of Mexico Stock and the Western North Atlantic Stock (Allen and Angliss, 2015). Though Cuvier’s beaked whales can be found nearly anywhere in >200 m (656 ft) deep waters, they prefer waters near the continental slope, especially those with a steep sea bottom (Taylor et al., 2008a). There is no minimum population estimate or estimated population size for this species (Allen and Angliss, 2015).

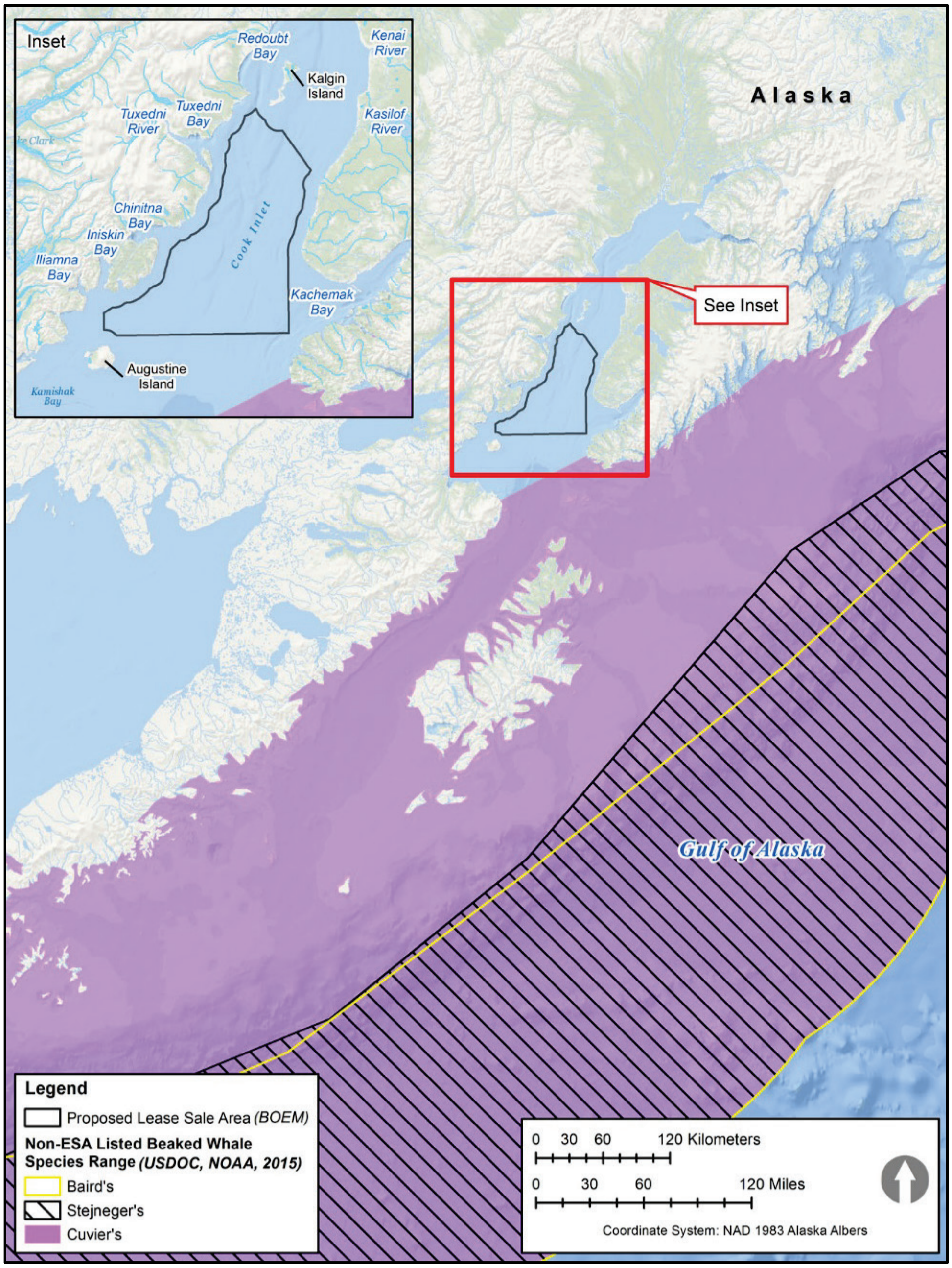


Figure 3.2.3-13. Beaked Whale Species Range Map. *Source: NOAA, 2015b*

Baird's Beaked Whale (*Berardius bairdii*)

The Baird's beaked whale is uncommon in the Action Area (NOAA, 2015b; Appendix A Section A-1). In the eastern North Pacific, they can be found north of 28°N to the southern Bering Sea, and in the western North Pacific from 34°N to the Okhotsk Sea (NMFS, 2012b), although their distribution in the mid-Pacific is less well-documented (Balcomb, 1989; Kasuya, 2002) (Figure 3.2.3-14). An apparent break in distribution occurs in the eastern Gulf of Alaska, but from the mid-Gulf of Alaska to the Aleutian Islands and in the southern Bering Sea, there are numerous recorded sightings (Forney and Brownell, 1996; Kasuya and Ohsumi, 1984; Moore et al., 2002). In the Sea of Okhotsk and the Bering Sea, Baird's beaked whales arrive in April and May, are numerous during the summer, and decrease in October (Kasuya, 2002; Tomilin, 1957). Observations of Baird's beaked whales were made during a survey in 2007 and again in 2011 in the western Bering Sea in all months except winter (December to March) around the Commander Islands, with encounters peaking in April to June, and to a lesser extent in August to November (Fedutin et al., 2012). During winter months, they rarely are found in offshore waters (Kasuya, 2002). However, acoustic detections of Baird's beaked whales from November through January (and no detections of them in July to October) in the northern Gulf of Alaska suggest that this region may be wintering habitat for some Baird's beaked whales (Baumann-Pickering et al., 2012a). There were no detections of this species from early June to late August 2010 off Kiska Island (Baumann-Pickering et al., 2012b).

Baird's beaked whales prefer cold deep oceanic waters ≥1,000 m (3,280 ft), and occasionally may occur near shore along narrow continental shelves (Kasuya, 2002; NMFS, 2012b).While diving, the Baird's beaked whale generally feeds between depths of 800 to 1,200 m (2,625 to 3,937 ft) on deep sea and deep water fish (e.g. mackerel, sardines, and saury), crustaceans, sea cucumbers, and cephalopods (e.g. squid and octopus) (Balcomb, 1989; Kasuya, 2002; NMFS, 2012b). The diet off the Pacific coast of Japan consists of 82% fish and 18% cephalopods, while in the southern Sea of Okhotsk the proportions are 13% and 87%, respectively (Taylor et al., 2008b).

For management purposes, Baird's beaked whales inhabiting U.S. waters have been divided into two stocks: the Alaska Stock and the California/Oregon/Washington Stock (NMFS, 2012b). There is no minimum population estimate or estimated population size for this species (Allen and Angliss, 2015).

Stejneger's Beaked Whale (*Mesoplodon stejnegeri*)

The Stejneger's beaked whale is uncommon in the Action (NOAA, 2015b; Appendix A, Section A-1). Stejneger's beaked whales prefer the cold temperate and subarctic waters of the North Pacific Ocean (NMFS, 2012c). They generally are found in deep, offshore waters from 750 to 1,500 m (2461 to 4921 ft) depth, on or beyond the continental slope (Houston, 1990; Loughlin and Perez, 1985; Reeves et al. 2002). Stejneger's beaked whales have a distribution throughout the North Pacific that includes California, the Aleutian Islands, and the southwest Bering Sea, Kamchatka, Okhotsk Sea, and Sea of Japan (MacLeod et al., 2006; Mead, 1989; NMFS, 2012c) (Figure 3.2.3-14). The Stejneger's beaked whale is thought to be the only species of the genus common in Alaskan waters (Taylor et al., 2008c).

For management purposes, Stejneger's beaked whales inhabiting U.S. waters have been placed in the Alaska Stock and California/Oregon/Washington Stock (Allen and Angliss, 2015). There is no minimum population estimate or estimated population size for this species (Allen and Angliss, 2015).

3.2.4. Terrestrial Mammals

This section discusses terrestrial mammals that use coastal habitats of Cook Inlet that could be affected by oil and gas activities associated with the Proposed Action. Approximately 43 species of terrestrial mammals are known to occur in the lower Cook Inlet area (Table 3.2.4-1). None of these species are currently listed as threatened or endangered, and most populations at the species level are considered stable (International Union for Conservation of Nature (IUCN), 2015). At the subspecies level, however, the Cook Inlet area, in particular, the Kenai Peninsula and the Kodiak Archipelago, have a high number of subspecies that are geographically and genetically isolated (ADNR, 2001; USFWS, 2010a). Fourteen species of terrestrial mammals are known to use marine coastal environments to significant extent: the brown bear (*Ursus arctos*), black bear (*Ursus americanus*), gray wolf (*Canus lupus*), coyote (*Canus latrans*), red fox (*Vulpes vulpes*), American mink (*Neovison vison*), river otter (*Lontra canadensis*), Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), caribou (*Rangifer tarandus*), Roosevelt elk (*Cervus elaphus roosevelti*), moose (*Alces americanusalces gigas*), Dall sheep (*Ovis dalli*), mountain goat (*Oreamnos americanus*), and hoary marmot (*Marmota caligata*). This section describes the life history characteristics of these species, their habitats and seasonal movements, and presents available population estimates, and, where applicable, describes annual losses due to hunting and non-hunting activities.

Table 3.2.4-1. Terrestrial Mammal Species of Cook Inlet.

Order	Common Name	Scientific Name	Habitat
Lipotyphia	Masked shrew	*Sorex cinereus*	Most vegetated terrestrial habitats
Lipotyphia	Pygmy shrew	*Sorex hoyi*	Grassy openings of boreal forest
Lipotyphia	Dusky shrew	*Sorex monticolus*	Variety of habitats
Lipotyphia	Water shrew	*Sorex palustris*	Riparian and lentic habitats
Lipotyphia	Tundra shrew	*Sorex tundrensis*	River meadows with osier
Chiroptera	Little brown bat	*Myotis lucifugus*	Forested lands near water
Carnivora	Brown bear	*Ursus arctos*	Variety of habitats
Carnivora	Black bear	*Ursus americanus*	Variety of habitats
Carnivora	Gray wolf	*Canis lupus*	Variety of habitats
Carnivora	Coyote	*Canis latrans*	Variety of habitats
Carnivora	Red fox	*Vulpes vulpes*	Variety of habitats
Carnivora	Canada lynx	*Lynx canadensis*	Boreal forest
Carnivora	Short-tailed weasel	*Mustela erminea*	Variety of habitats
Carnivora	Least weasel	*Mustela nivalis*	Variety of habitats
Carnivora	River otter	*Lontra canadensis*	Riverine habitat and coastal marshes areas
Carnivora	American mink	*Neovison vison*	Vegetated river courses and other wetlands
Carnivora	American marten	*Martes americana*	Mature coniferous forests
Carnivora	Wolverine	*Gulo gulo*	Variety of habitats
Artiodactyla	Sitka black-tailed deer	*Odocoileus hemionus sitkensis*	Variety of habitats
Artiodactyla	Caribou	*Rangifer tarandus*	Tundra, open montane and woodland habitats
Artiodactyla	Roosevelt Elk	*Cervus elaphus roosevelti*	Open montane and woodland habitat, meadows and grasslands, coastal areas on islands.
Artiodactyla	Moose	*Alces americanusalces gigas*	Mosaic of second-growth boreal forest, openings, lakes, wetlands
Artiodactyla	Dall sheep	*Ovis dalli*	Subalpine grasslands and shrublands in dry mountainous regions coastal mountains
Artiodactyla	Mountain goat	*Oreamnos americanus*	Alpine and subalpine coastal mountains
Lagomorpha	Collared pika	*Ochotona collaris*	Rocky areas in proximity to vegetation
Lagomorpha	Snowshoe hare	*Lepus americanus*	Boreal and mixed forest with dense understory
Rodentia	Hoary marmot	*Marmota caligata*	Treeless alpine meadows with rocky outcrops rockslides in coastal areas
Rodentia	Arctic ground squirrel	*Spermophilus parryii*	Alpine and subalpine meadows, open tundra, coastal sand ridges
Rodentia	Red squirrel	*Tamiasciurus hudsonicus*	Coniferous and mixed forests
Rodentia	Northern flying squirrel	*Glaucomys sabrinus*	Coniferous and mixed forests, riparian woods
Rodentia	North American porcupine	*Erethizon dorsatum*	Variety of habitats
Rodentia	North American beaver	*Castor canadensis*	Lakes, ponds, and streams
Rodentia	Meadow jumping mouse	*Zapus hudsonius*	Grassy fields, thick riparian vegetation, wooded areas
Rodentia	Norway rat	*Rattus norvegicus*	Lowland and coastal areas with human populations - introduced
Rodentia	House mouse	*Mus musculus*	Man-made habitats - introduced
Rodentia	Meadow vole	*Microtus pennsylvanicus*	Variety of habitats
Rodentia	Singing vole	*Microtus miurus miurus*	Variety of habitats
Rodentia	Root vole	*Microtus oeconomus*	Damp, densely vegetated areas
Rodentia	Northern red-backed vole	*Myodes rutilus*	Mature forests with dense understory
Rodentia	Muskrat	*Ondatra zibethicus*	Brackish and freshwater aquatic habitat

Verification of presence in Cook Inlet area, habitat and conservation status: IUCN (2015).
Source: (AKNHP, 2013).

The ADFG has divided the state into 26 Game Management Units (GMUs), which are further divided into subunits in many cases. In order to maintain consistency in the discussion of animal populations, this section will describe populations in relation to GMUs where applicable.

The GMUs relevant to this section are described as follows (ADFG, 2015a):

- **GMU 6:** All of the Gulf of Alaska and Prince William Sound drainages from the center line of Icy Bay (excluding the Guyot Hills) to Cape Fairfield, including Kayak, Hinchinbrook, Montague, and adjacent islands, and Middleton Island, but excluding the Copper River drainage upstream from Miles Glacier, and excluding the Nellie Juan and Kings River drainages.
- **GMU 7:** Gulf of Alaska drainages between Gore Point and Cape Fairfield, including the Nellie Juan and Kings River drainages, and including the Kenai River drainage upstream from the Russian River, the drainages into the south side of Turnagain Arm west of and including the Portage Creek drainage, and east of 150°W, and all Kenai Peninsula drainages east of 150°W, from Turnagain Arm to the Kenai River.
- **GMU 8:** All islands southeast of the centerline of Shelikof Strait, including Kodiak, Afognak, Whale, Raspberry, Shuyak, Spruce, Marmot, Sitkalidak, Amook, Uganik, and Chirikof Islands, the Trinity Islands, the Semidi Islands, and other adjacent islands.
- **GMU 9:** The Alaska Peninsula and adjacent islands, including drainages east of False Pass, Pacific Ocean drainages west of and excluding the Redoubt Creek drainage, drainages into the south side of Bristol Bay, drainages into the north side of Bristol Bay east of Etolin Point, and including the Sanak and Shumagin Islands.
- **GMU 14:** Drainages into the north side of Turnagain Arm west of and excluding the Portage Creek drainage, drainages into Knik Arm excluding drainages of the Chickaloon and Matanuska Rivers in Unit 13, drainages into the north side of Cook Inlet east of the Susitna River, drainages into the east bank of the Susitna River downstream from the Talkeetna River, and drainages into the south and west bank of the Talkeetna River to its confluence with Clear Creek, and west side drainages along a line up the south bank of Clear Creek to the first unnamed creek on the south, then up that unnamed creek to lake 4408, along the northeast shore of lake 4408, then southeast in a straight line to the northernmost fork of the Chickaloon River.
- **GMU 15:** That portion of the Kenai Peninsula and adjacent islands draining into the Gulf of Alaska, Cook Inlet and Turnagain Arm from Gore Point to the point where longitude line 150°W crosses the coast line of Chickaloon Bay in Turnagain Arm, including that area lying west of longitude line 150°W to the mouth of the Russian River, thence southerly along the Chugach National Forest boundary to the upper end of Upper Russian Lake, and including the drainages into Upper Russian Lake west of the Chugach National Forest boundary.
- **GMU 16:** The drainages into Cook Inlet between Redoubt Creek and the Susitna River, including Redoubt Creek drainage, Kalgin Island, and the drainages on the west side of the Susitna River (including the Susitna River) upstream to its junction with the Chulitna River; the drainages into the west side of the Chulitna River (including the Chulitna River) upstream to the Tokositna River, and drainages into the south side of the Tokositna River upstream to the base of the Tokositna Glacier, including the drainage of the Kanitula Glacier.

3.2.4.1. Brown Bear

With an estimated population of 32,000 brown bears, Alaska supports over 98% of the U.S. population, and >70% of the North American population (ADFG, 2015a). The relative isolation of the Kodiak Archipelago has resulted in the evolution of subspecies of brown bear, *Ursus arctos middendorffi* (Van Daele and Crye, 2011a) endemic to these islands. A subspecies endemic to the

Kenai Peninsula, *Ursus arctos kenai,* has been proposed, but is not yet widely accepted (Jackson, Talbot, and Farley, 2008). The Cook Inlet area, including the Kodiak Archipelago and Alaska Peninsula, supports some of the highest densities of brown bear in the world (Glenn, 1980). Miller et al. (1997) found that coastal areas with abundant runs of salmon supported brown bear densities 6 to 80 times greater than interior areas. The Katmai region at the northern end of the Alaska Peninsula (primarily within GMUs 9A and 9C) supports a population estimated at >6,000 brown bars, with the highest population densities of brown bear in North America, approximately 551 bears per 1,000 km^2 (386 mi^2) (Miller et al., 1997). The total population of brown bears within GMU 9 is estimated at 8,000 to 9,300 (Riley and Butler, 2011). The Kodiak Archipelago (GMU 8), well known for producing the largest brown bears in North America, supports an estimated 3,526 brown bears at a density of approximately 286 bears per 1,000 km^2 (386 $mile^2$) (Van Daele, 2007; Van Daele and Crye, 2011a). Prince William Sound and the north Gulf Coast of Alaska (GMU 6) support an estimated 3,000 bears, at a density of 330 to 850 per 1,000 km^2 (386 $mile^2$), ADFG, 2015a). GMU 16B (i.e., all of GMU 16 with the exception of GMU 16A at the easternmost end of GMU 16, which is outside the proposed Lease Sale Area) has a population estimated at between 625 and 1,250 brown bears (Peltier, 2011a). The Kenai Peninsula (GMUs 7 and 15) supports an estimated 582 brown bears at a density of 42 bears per 1,000 km^2 (386 $mile^2$) (USFWS, 2014c). GMU 14A at the upper end of Cook Inlet supports an estimated 30 to 60 brown bears (Peltier, 2011b), while the Municipality of Anchorage (GMU 14C) may support between 65 and 75 bears (Coltrane, 2011a).

Coastal regions of Alaska support the highest densities of brown bears, and also the largest specimens (Glenn, 1980). While exploitation of summer and fall salmon runs by brown bears, in order to rapidly gain weight in preparation for hibernation, is well known, the coastal environment also provides important nutritional resources during the spring and early summer when bears need to rapidly replace body mass lost during hibernation. Coastal salt marshes provide a wide variety of herbaceous vegetation during the spring such as sedges (*Carex* spp.), grasses (*Elymus* spp.), and forbs (*Plantago* spp. and *Triglochin* spp.) that are an abundant source of highly digestible protein (Smith and Partridge, 2009). Susitna Flats State Game Refuge (ADFG, 2015a) and Redoubt Bay on the west side of Cook Inlet are important grazing areas for brown bears during the spring (ADNR, 2009b) while Bruin Bay and Kukak Bay at the north end of the Alaska Peninsula provide important foraging areas supporting large brown bear concentrations during the spring (USDOI, 1980). Intertidal foraging also provides substantial nutrition in the form of mussels (*Mytilus* spp.), barnacles (*Balanus* spp.), clams (*Mya* and *Siliqua* spp.), marine worms (*Nereis* spp.), fish (*Ammodytes* spp.), and other species. Feeding on intertidal clams was observed to be particularly important to female bears with dependent young, as well as newly independent smaller bears, as they could maximize nutrition gained in relation to time expended foraging (Smith and Partridge, 2009). These intertidal areas support large concentrations of bears until the arrival of salmon draw the bears to spawning rivers, particularly the Kustatan River on the west side of Cook Inlet, the mouth of the Susitna River at the north end of Cook Inlet, the Anchor River on the Kenai Peninsula (ADNR, 2009b) and the McNeil River in the Katmai region of the Alaska Peninsula. The McNeil River area, designated as a wildlife sanctuary in 1967, hosts the world's largest concentration of brown bears (ADFG, 2015a). Ungulates, both adult and newborn, are also included in the diet of the brown bear (ADNR, 2009b; ADFG, 2015a). Salmon runs are important for maintaining brown bear populations in the Cook Inlet region. Brown bears have also been observed using sea ice as supplemental hunting habitat, as well as using it to access islands 161 km (100 mi) or more offshore (Struzik, 2006).

The highly productive coastal habitats of the Cook Inlet area support the production of higher numbers of offspring among the brown bear population in this area than elsewhere. Litters of three cubs are more common on the Alaska Peninsula than in other areas, while litters of four cubs are known only from the Alaska Peninsula and the Kodiak Island archipelago (Modafferi, 1984). Brown bears inhabiting the coastal areas surrounding Cook Inlet are living near or at the carrying capacity of these habitats (Sellers and Miller, 1999).

The Kenai Peninsula population of brown bears was listed as a population of special concern in 1998 by ADFG (ADFG, 2000). This population was determined to be "vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance" in an area experiencing increased human activity. Alaska eliminated the "species of special concern" list in 2011, as it had not been reviewed or revised since 1998 and was no longer considered valid (ADFG, 2016). Since that time ADF&G has used the Alsaka Wildlife Action Plan to "assess the needs of species with conservation concerns and to prioritize conservation actions and research" (ADFG, 2016). This change in management strategy does not reflect a change in the status of the Kenai Peninsula brown bear population. The Kenai brown bear population remains insular, showing less genetic diversity than mainland brown bear populations. The Kenai population is subject to increased pressure from a rapidly growing human population (USFWS, 2014a). While brown bears occur throughout the Cook Inlet area, they concentrate seasonally at different locations. Specific locations (such as those described above) become even more important as the population or suitable habitat declines (The Nature Conservancy, 2003).

The Kenai Peninsula is connected to the adjacent mainland by a 16-km wide isthmus that presumably restricts exchange of bears between the peninsula and the mainland. The peninsula also is one of the fastest urbanizing areas of Alaska (USFWS, 2014c). Human activity (logging, mineral and energy development, and water impoundments) has reduced the effectiveness of habitat within the Chugach National Forest portion of the Kenai Peninsula by approximately 70% (Suring, et al., 1998). Increased human activity has also increased the likelihood of bear-human conflicts and bear mortality. The increase in human activity on Kenai Peninsula has led to "a significant increase in the number of bears killed to protect life and property" (ADFG, 2000). During the 1990s, the average number of bears killed in defense of life and property more than doubled from 2.5 bears per year to more than 6 (ADFG, 2000). A population survey of Kenai Peninsula brown bears conducted by USFWS (USFWS, 2014c) estimated a sex ratio of 50:50. A more typical ratio is 60 females:40 males, suggesting that female mortality is skewed high. Of 122 bears killed by humans through other causes than hunting, 69% were females (USFWS, 2014c). The low proportion of females in the Kenai brown bear population has serious implications with respect to maintenance of this geographically insular population.

The vulnerability of the Kenai Peninsula brown bear population is reflected in the low harvest numbers in GMUs 7 and 15, (the east side of the Kenai Peninsula, GMU 7, is managed in combination with GMU 15, the west side of the Kenai Peninsula), as well as the high number of bears killed in non-hunting incidents (i.e., defense of life or property, illegal kills, roadkill, etc.). During the Regulatory Year (RY) 2009 (RY09 – i.e., 1 July 2009 – 30 June 2010) hunting season, five brown bears were harvested by hunters, while 21 bears were killed in non-hunting cases (Selinger, 2011a). Similar numbers were reported in GMU 14c where 2 bears were harvested by hunters in RY09, while 10 were reported killed in non-hunting incidents (Coltrane, 2011a). A more stable brown bear population is found in GMUs 14a & b (upper Cook Inlet) where 21 brown bears were taken by hunters in RY09, while 4 were reported killed in non-hunting incidents (Peltier, 2011b). GMU 16 (the west side of Cook Inlet) reported similar numbers in RY09: 17 bears harvested by hunters, 3 bears lost to other types of human-caused mortality (Peltier, 2011a). A harvest of 86 brown bears was reported in GMU 6 during RY09 (Crowley, 2011a). In GMU 8 (Kodiak and adjacent islands), 201 bears were harvested in RY09 with an estimated 31 non-hunting losses (Van Daele et al., 2011a). GMU 9 contains one of the highest brown bear densities on the planet, and this is reflected in hunting (597 bears in RY09) and estimated non-hunting losses of 50 to 100 brown bears per year (Riley and Butler, 2011).

3.2.4.2. Black Bear

Alaska supports a population of approximately 100,000 black bears (ADFG, 2015a). Black bears range throughout the Cook Inlet area from sea level to alpine areas (ADFG, 1994). Approximately

3,500 black bears are believed to inhabit the Prince William Sound area (GMU 6) at a density of 590 bears per 1,000 km^2 (386 mi^2) (Crowley, 2011b). Over 4,000 black bears are estimated to inhabit GMUs 7 and 15, the Kenai Peninsula (Selinger, 2011b), at a density of approximately 289 bears per 1,000 km^2 (386 mile^2) (Miller et al., 1997), the densest concentration of this species recorded in Alaska. From 500 to 1,000 black bears are estimated to occur in GMU 16A in the upper Cook Inlet area (41 to 82 bears per 1,000 km^2 (386 mile^2)), and from 1,825 to 3,650 in GMU 9A and 9C on the west side of Cook Inlet, approximately 147 to 194 bears per 1,000 km^2 (386 mi^2) (Peltier, 2011c). Black bear populations tend to be highest in areas with lower brown bear populations, and they are absent from the Kodiak Archipelago and the Alaska Peninsula, the areas of highest brown bear density (ADFG, 2015a). Black bears tend to avoid competition with brown bears by being more active in the daytime and by inhabiting more densely forested areas. In areas with abundant and varied food sources, feeding preferences also separate the two species (Mattson, Herrero, and Merrill, 2005).

Cubs, most commonly two, are born during hibernation and remain with their mothers through the following winter. Like brown bears, black bears in the Cook Inlet area are heavily dependent upon coastal habitats from the time they emerge from hibernation until they return to their dens in the fall. Upon emerging from hibernation, black bears mainly eat freshly sprouted green vegetation, but they also prey on newborn moose calves (ADFG, 2015a). Spring concentrations of black bears have been recorded along the shore at Redoubt and Trading Bays, the Kustatan River, the upper McArthur River, the Susitna Flats State Game Area (ADFG, 2015a) and slopes between Drift River and the South Fork Big River on the west side of Cook Inlet (ADNR, 2009b). Berries, particularly blueberries and devil’s club, typically form a larger part of the black bear’s diet than that of the brown bear. A recent study (Fox, Paquet, and Reimchen, 2015) at Quatsino Sound on the Pacific coast of British Columbia found that eggs of the Pacific herring formed a substantial component of the early springtime diet of black bears in that area. Pacific herring occurs in the lower Cook Inlet and may play a role in the early spring diet of the area’s black bears. During the summer and fall, black bears concentrate feeding activity on spawning salmon in areas where they area available (ADFG, 2015cc). Where salmon are absent, black bears rely heavily on vegetation, supplementing their diet with berries and insects (ADFG, 2015a).

A total of 672 black bears were harvested from GMU 6 during RY09, 527 of these from subunit 6D at the western end of Prince William Sound (Crowley, 2011b). The black bear population of the Kenai Peninsula (GMUs 7 and 15) is stable enough to have supported year-round hunting since 1980, with 619 bears taken through hunting and non-hunting activity in RY09 (Selinger, 2011b). In GMU 14A and 14B, 92 black bears were harvested in RY09, while an estimated 11 bears were lost through non-hunting incidents (Peltier, 2011c). Within the Municipality of Anchorage (GMU 14c), the low number of bears taken by hunters (41), combined with a high non-hunting mortality (29 bears), reflect the stress experienced by this population in Alaska’s most densely populated urban area (Carnahan and Coltrane, 2011). The recreational harvest in GMU 16 (the west side of Cook Inlet) in RY09 was 100 bears, while an estimated 10 were lost to other human activity (Peltier, 2011d). Black bears are absent from GMUs 8 and 9 (Kodiak and adjacent islands and the Alaska Peninsula).

3.2.4.3. Gray Wolf

Wolves are the top terrestrial predator in Alaska (Wright, 2011), and the state supports an estimated 7,000 to 11,000 wolves. Wolves are considered common throughout most of the state, and have never been listed as threatened or endangered in Alaska. The gray wolf is found throughout the Cook Inlet area with the exception of the Kodiak Archipelago and islands in the Gulf of Alaska (ADFG, 2016). GMU 6 (Prince William Sound area) supports an estimated 49 to 63 wolves and appears capable of sustaining an average annual harvest of 10 animals (Crowley, 2012). Wolves were extirpated from the Kenai Peninsula (GMUs 7 and 15) during the early 20th century, but returned to the peninsula in the early 1960s and by the mid-1970s had colonized most available habitat. Currently the Kenai

Peninsula supports approximately 200 wolves and appears to be relatively stable (Selinger, 2012a). Wolf populations on the Alaska Peninsula (GMUs 9 & 10) appear to be stable and are conservatively estimated at 350 to 550 wolves (Riley, 2012a). No systematic surveys of wolf populations have been conducted in GMU 14 (eastern upper Cook Inlet); however, based on observations by ADFG staff, trappers, and the public, it appears that the wolf population in this area is above the management objective of 35 animals in Units 14A and 14B (Peletier, 2012a) and 20 animals in 14C (Battle, 2012a). An estimated 120 to 140 wolves inhabit GMU 16 (West side of Cook Inlet). The management goal in GMU 16 is to reduce the wolf population to 30 to 60 wolves (Peletier, 2012b).

Wolves are social animals living in packs that average six or seven animals, although much larger packs (20 to 30 wolves) occasionally occur. Mating is typically limited to the alpha male and female of the pack and typically takes place in February and March (Wright, 2011). Pups are born between early May and early June (Wright, 2011), with an average litter size of about seven pups (ADFG, 2016). Despite the high birthrate, mortality also is high, the major sources of mortality being hunting, trapping, and predation by other wolves (ADFG, 2016).

Wolves are carnivores and moose and/or caribou constitute their primary food (ADFG, 2016). In coastal areas, wolves are known to supplement their diet through scavenging fish and marine mammal carcasses (Watts et al., 2010), while salmon runs provide a seasonally abundant food source (ADFG, 2016; Crowley, 2012; Riley, 2012a). Wolves have been observed using pack ice to access islands, scavenge, and hunt (Richardson and Andriashek, 2006). Some packs will leave their regular territory to take advantage of the abundance of spawning salmon (Wright, 2011).

3.2.4.4. Coyote

Atypical of most upper level predators, coyotes have expanded their range and numbers, largely because of, human impacts on the environment. Clearing of forests and the elimination of reduction in the populations of other predators – particularly wolves – have contributed to this expansion (ADFG, 2016; Gese, et al., 2008). First noted in southeast Alaska in the early 20th century, coyotes since have expanded throughout most of the state including the Cook Inlet area, with the exception of the Alaska Peninsula and the Kodiak Archipelago (ADFG, 2016).

Coyotes are opportunistic predators feeding on foods ranging from fruits, insects, and fish to rodents and ungulates, and will scavenge when the opportunity is presented (ADFG, 2016). Mating takes place between January and March with an average of 6 pups born approximately 2 months later. At the age of three and a half months, pups are able to capture food on their own. Coyotes are managed as a furbearer in Alaska, and may be hunted year-round with no limit throughout the Cook Inlet area, (ADFG, 2016).

3.2.4.5. Red Fox

The red fox is common throughout most of northern North America including Alaska (ADFG, 2016). The red fox is omnivorous, eating vegetation, eggs, insects, birds, small mammals, and carrion. It will also take advantage of the seasonal abundance of spawning salmon, both capturing live fish and scavenging carcasses (Cederholm et al., 1999). Breeding takes place in February and March with an average of 4 pups born 51 to 54 days later. By the age of 3 months, pups begin to hunt on their own, and by autumn are ready to leave the mother. The red fox is managed as a furbearer in Alaska with no limit throughout most of the Cook Inlet area, with the exception of Chugach State Park where the limit is 1 fox per season (ADFG, 2015a).

3.2.4.6. American Mink

The American mink (*Neovison vison*) is found throughout the state of Alaska with the exception of Kodiak Island, the Aleutian Islands, the offshore islands of the Bering Sea and most of the Arctic Slope. Mink are found near water, in areas such as lakeshores, stream banks, and saltwater beaches, with most activity taking place within one to two m (3 to 7 ft) of shoreline. Mink prefer vegetative shorelines as they provide more prey and offer protection from predators (Larivière, 2003). In southeast Alaska, mink have been observed moving from streamside summer habitat to ocean beaches in winter (Meehan, 1974). In coastal areas mink prefer shallow vegetated slopes and tidal slopes with protection from wave action and understory cover (ADFG, 2015a). American mink and river otters living in marine environments in Alaska show niche separation through resource partitioning probably related to the swimming abilities of these mustelids, with mink preferring sites with lower wave exposure than sites preferred by river otters (Ben-David, Bowyer, and Faro, 1996). Mink are strictly carnivorous, consuming fish, amphibians, crustaceans, and small mammals, and their diets vary depending on the availability of prey. Fish, shellfish, and crustaceans are the primary food items of mink in coastal habitats in Alaska and British Columbia (Allen, 1986; Harbo, 1958; Hatler, 1976). Alaskan mink typically breed in April with four to ten kits born in June. They grow rapidly and reach adult size by September. Mink are managed as furbearers in Alaska with no bag limit. Mink are believed to be stable or increasing in most GMUs (ADFG, 2015a).

3.2.4.7. River Otter

River otters (*Lontra canadensis*) are found throughout the Cook Inlet region. Testa et al. (1994) estimated densities in Prince William Sound ranged from 0.28 to 0.80 animals per km^2. Due to proximity and similar habitat, it is expected that population densities in the Cook Inlet area are similar to those in Prince William Sound. Small fish, molluscs, crustaceans and other invertebrates, and occasionally birds, mammals, and vegetation form the bulk of their diet (ADFG, 2015a). Fish, particularly cottids (sculpins) and scorpaenids (rockfish), are an important food for otters in the marine environment (Larsen, 1984). In Alaska, river otters breed in spring, usually in May, with one to six pups born nine to thirteen months later. At the age of about two months, pups begin to leave the den, with the mother teaching them to swim. The young stay with the mother until shortly before the next litter is born (ADFG, 2015a).

Fish consumed by otters tend to be species typical of shallow, nearshore waters (Larsen, 1984). Blundell, Maier, and Debevec (2001) reported that river otters in Prince William Sound foraged an average distance of 5.1 m (16 ft) from shore. However, coastal river otters have been observed forming large groups, comprised primarily of males, enabling them to forage more efficiently in deeper water where they catch schooling pelagic fish (e.g., herring and salmon) that have a higher nutritional value than those found in shallow waters close to shore. Female otters with young typically forage in shallower waters, closer to their dens, presumably in order to reduce predation risk, as the arrival of pelagic fish in Prince William Sound in late summer corresponds with the emergence of young from natal dens (Blundell, Ben-David, and Bowyer, 2002).

A subspecies of river otter (*Lontra canadensis kodiacensis*) is restricted to Kodiak Island and surrounding islands. The population of this subspecies is listed as “apparently secure” but it is considered highly vulnerable biologically (Alaska Natural Heritage Program (AKNHP), 2012). River otters are not directly managed in Alaska and are open to trapping with no bag limit (ADFG, 2015a).

3.2.4.8. Black-tailed Deer

The Sitka black-tailed deer is not native to the Cook Inlet area, but a total of 25 deer were introduced to Kodiak and Long Islands in a series of four translocations, between 1924 and 1934 (Burris and McKnight, 1973; ADFG, 2015a). Deer also were introduced to Hinchinbrook and Hawkins Islands in Prince William Sound between 1917 and 1923 (Woodford, 2006a), and soon spread to neighboring islands and the nearby mainland. They are currently found on Kodiak, Afognak, Raspberry, Sitkinak and Tugidak Islands, and in coastal areas of Prince William Sound, including Montague Island, with a total population numbering over 60,000 deer (ADNR, no date; ADFG, 2015a).

Deer begin moving into winter ranges in late October (Van Daele and Crye, 2011b) with breeding taking place in late November. Winter mortality on these islands is the most significant factor limiting the deer population, particularly in the Kodiak Archipelago which lacks the dense forest canopy that protects winter forage areas in the rest of this species' range in Alaska (Paul, 2009). During severe winters, coastal habitat may provide most of the available food. Beaches and exposed capes are the primary winter range on these islands; kelp is a favored food in those areas where it accumulates on shore (Veeramachaneni, Amann, and Jacobson, 2006). Woody browse such as heath, crowberry, low cranberry, bearberry, red elderberry, blueberry and willow found near sea level also provide forage during the winter, while newly emerged sedges are grazed on beaches in the spring (ADFG, 2015a; Van Daele and Crye, 2011b; Wallmo and Schoen, 1979). Fawns, typically two, are born in late spring (ADFG, 2015a), after which deer emerge from the shelter of lower elevation forests to follow the snowmelt to higher alpine areas.

No estimate of population size is available for GMU 6 (Prince William Sound and islands), as estimating a population has not been a management priority due to the difficulty of finding and counting forest dwelling animals. The population objective is 24,000 to 28,000 deer with a harvest objective of 2,200 to 3,000 animals. The harvest reported in RY11 was 2,021 deer, including an estimated 264 illegal or unrecovered mortalities. Recent harvest numbers would indicate that the current population is below the management objective, largely due to recent severe winters (Westing, 2013). Winter mortality was also high in GMU 8 where an estimated 40% of the herd perished during the winter of 2011-2012. The population estimate, based on hunter questionnaires, in GMU 8 in 2012 was 45,000 deer, well below the management objective of 70,000 to 75,000 individuals (Van Daele, Svoboda, and Crye, 2013). The legal harvest in RY11 was 4,804 deer, also below the management objective of 8,000 to 8,500 individuals. In addition, an estimated 480 were harvested illegally and another 480 were lost due after being wounded. An estimated 40 to 50 deer are killed annually by automobiles (Van Daele, Svoboda, and Crye, 2013).

3.2.4.9. Caribou

Five herds of caribou are found in the Cook Inlet area, one on the north end of the Alaska Peninsula, and four on the Kenai Peninsula. Caribou (*Rangifer tarandus stoneii*) were extirpated from the Kenai Peninsula by 1912 and the current population is descended from Nelchina Herd translocations during the 1960s and 1980s (USFWS, 2014d).

The Northern Alaska Peninsula caribou herd occupies a large area of the Alaska Peninsula and the Northern Alaska Peninsula caribou herd population is estimated at 2,300 to 2,500, well below the 12,000 to 15,000 animal management objective. This population has been in decline since at least 1992, though the rate of decline may be slowing (Riley, 2011).

The Kenai Mountains herd at the northern end of the Kenai Peninsula is the largest on the peninsula with an estimated population of 300 caribou. According to McDonough (2011a), the population is approaching carrying capacity of about 400 animals. The Kenai Mountains herd utilizes alpine and subalpine habitat at elevations between 2,000 and 4,500 ft. The Killey River herd in the upper Killey, Funny, and Skilak River drainages in the central Kenai Peninsula numbers approximately 250 caribou. The Fox River herd of 50 to 75 caribou occupies alpine and subalpine between the Tustumena Glacier and the Fox River, upriver from the head of Kachemak Bay near the southern end of the Kenai Peninsula. All three herds occupy alpine and subalpine habitat year-round with no separate winter or summer range. Calving takes place on higher mountain ridges at >1,220 m (4,000 ft) for all three herds (USFWS, 2014d).

The Kenai Lowlands herd on the west coast of the central Kenai Peninsula numbers 120 to 150 animals (USFWS, 2014d). Unlike the other herds in the Cook Inlet area, the Kenai Lowlands herd maintains separate summer and winter ranges, and has the largest range of the Kenai Peninsula herds. The Kenai Lowlands herd winters in the spruce forest and open muskeg of the Moose River

Flats, about 27 km (17 mi) east of the mouth of the Kenai River. In April or early May, the herd moves down the Kenai River to calving areas in the wetlands north of the Kenai Airport, along the Kenai River flats, and wetlands in the Kenai gas fields. Calving takes place from mid-May through early June, and the herd remains on these calving grounds through the summer. In October, the herd makes a return migration up the Kenai River to the Moose River flats (ADFG, 2003).

Caribou populations on the Kenai Peninsula are stable or increasing, except for the Fox River herd. The Kenai Mountains herd, Killey River herd, and Fox River herds are the only herds hunted on the Kenai Peninsula. The hunting season for the Kenai Lowlands herd, open from 1981 to 1994, was closed in 1994 and still remains closed. Thirteen caribou from the Kenai Lowlands herd were killed from highway accidents between 2000 and 2003. Harvest numbers for caribou herds of the Kenai during the RY09 season are as follows: Kenai Mountains herd, 18 animals: Killey River herd, 6 animals (McDonough, 2011a). The season for the Fox River herd was closed in 2004 and reopened in 2011. The latest harvest information available for the Fox River herd is from RY03 when one animal was harvested (ADFG, 2003).

3.2.4.10. Elk

All elk currently inhabiting Alaska are the result of introductions that took place in the 20^{th} century. Eight Roosevelt elk calves were transplanted from the Olympic Peninsula of Washington State and released on Afognak Island in 1929. Since their introduction, elk have spread to Raspberry Island. Populations peaked in the late 1990s at an estimated 1,400 animals and then began to decline, largely due to a series of severe winters. As of 2010-2011, the population consisted of approximately 610 animals in seven herds on Afognak Island and one on Raspberry Island, and these are believed to be declining (Van Daele and Crye, 2012).

Elk are grazers, consuming grasses and other leafy vegetation from late spring to early fall. Calves typically are born in late May or early June, usually within the cover of dense spruce forests, when food is plentiful and the weather mild. In August, elk begin to form herds consisting of cows, calves, yearlings and occasionally mature bulls. Bull elk usually form small bands occupying areas near the herds of females and young, joining the main herds in September when mating activity begins. By mid-October, mating activities have ceased, and elk begin to disperse into smaller bands relocating to wintering areas. At this time elk shift from grazing to browsing, feeding on the branches and sprouts of trees and shrubs (ADFG, 2015a). During the winter, elk on Afognak and Raspberry Islands seek shelter in low-lying coastal areas, where they are dependent upon willow and elderberry (AKNHP, 2011).

A total of 62 elk were harvested in GMU 8, which includes Afognak and Raspberry Islands, during the 2014 hunting season (Svoboda and Crye, 2014a). The loss due to wounding and illegal harvest is estimated at 15% of the reported harvest (Van Daele and Crye, 2012).

3.2.4.11. Moose

Moose are found throughout the Cook Inlet area with the exception of the Kodiak Archipelago, and mountainous areas (ADNR, 2009b). They are particularly abundant in riparian areas, recently burned areas with willow and tree saplings, and on timberline plateaus (ADFG, 2015a; ADNR, 2009b).

Flooding and fire maintain dense stands of willows and other fast-growing plants that provide abundant browse for moose (Woodford, 2006b), and seasonal movements of moose are related to food availability as well as life cycle requirements. Calving occurs in early spring, typically in shrubby or forested areas that provide forage for mothers and cover for calves (Bowyer et. al., 1999). Important calving areas include the Skeentna, Yentna, Kahiltna, Susitna, Little Sisitna, and Matanuska Rivers, the Susitna Flats State Game Refuge, and the north and east coasts of Knik Arm (ADFG, 1985, 2015a). On the Kenai Peninsula, calving areas include the coastal areas between the Kenai and Kasilof Rivers, the head of Kachemak Bay, and the area northeast of Homer (ADNR, 2009a). In spring, moose cows give birth to one or two calves which remain with their mothers for around one year. In spring, moose forage on gramminoids, forbs, shrubs, and tree saplings, adding aquatic plants to their diet during summer. At wintering areas, such as the Susitna Flats State Game Refuge, and coastal or riparian areas, moose browse willow, birch, cottonwood, aspen, and occasionally young spruce tips (ADFG, 2015a; ADNR, 2009a).

Moose are an important big game species in Alaska. Population estimates, harvest totals, and the estimated number of accidental or illegal kills are taken from the 2012 Moose Management Report (ADFG, 2012), reflecting their numbers and status as of RY10. GMU 7 (Eastern Kenai Peninsula) supports between 600 and 800 moose, of which 24 were taken by hunting, and 15 killed by accidents or poaching. Predation by wolves and bear, as well as poaching, are thought to be important factors regulating the size of this population, however the net effect at this time is not quantified (Selinger, 2012b). GMU 9 (the entire Alaska Peninsula including subunit 9C at the westernmost end of the peninsula) supports approximately 3,500 animals, of which 84 were harvested in RY10, while an additional 100 are estimated to have been killed but not reported. Brown bear predation on neonatal moose, as well as illegal killing in select areas, are considered the primary limiting factors on this population (Riley, 2012b). GMU 14A (the Matanuska Valley) supports around 6,000 moose, the highest concentration of moose in the Cook Inlet area. A total of 707 moose from GMU 14Awere taken legally in RY10, with an estimated 109 additional moose deaths stemming from unreported/illegal kills and another 270 accidental kills - primarily road, but also rail, accidents (Peltier, 2012c). GMU 14B (the western Talkeetna Mountains) supported around 1,600 moose in RY09, when 80 moose were killed legally; another 28 were estimated to have been poached, and another 50 were killed in accidents (Peletier, 2012d). Within the Municipality of Anchorage (GMU 14C) vehicle and train kills accounted for about 62% of known human-related moose deaths, with 302 moose accidentally killed, and another 132 moose legally harvested, while about 20 moose were illegally harvested in RY08 – the most recent year for which complete harvest and accidental death records are available for this GMU (Battle, 2012b). GMU 15 (the western Kenai Peninsula) supports between 4,200 to 6,500 moose, of which 391 were legally harvested, with an additional 251 accidental moose deaths reported for GMU 15 in RY10 (Selinger, 2012c). The west side of the Susitna River (GMU 16A) supports around 2,500 moose, of which 126 were legally harvested, an estimated 29 were illegally killed, and an estimated 10 died from accidents in RY 10 (Peletier, 2012e). Unit 16B (the west side of Cook Inlet and Kalgin Island) supported an estimated 7,190 moose in RY 10, with 70 to 90 occupying Kalgin Island. A harvest of 227 moose occurred in GMU 16B during RY10, with an annual average of 25 coming from Kalgin Island (Peletier, 2012f).

3.2.4.12. Dall Sheep

In the Cook Inlet area, Dall sheep (*Ovis dalli dalli*) are found in the Kenai Mountains of the Kenai Peninsula, in the mountains of the Alaska Range on the west side of Cook Inlet, and in the mountains east of Anchorage along Turnagain Arm (ADFG, 1985; State of Alaska, 2016). Dall sheep generally are found in relatively dry habitats containing a combination of open alpine ridges, meadows and steep slopes, and occasionally in rocky gorges below timberline (ADFG, 2015a).

Dall sheep feed on a wide range of plants during the summer when food is abundant, and on dry, frozen grass and sedges, lichens, and mosses during winter. Mineral licks are an important nutritional resource for them in spring when different bands may congregate at a single mineral lick. An added benefit of such congregations might be the movement of individuals between groups which would help maintain genetic diversity within the population (ADFG, 2015a). One of these mineral licks is found near Windy Corner on the north coast of Turnagain Arm. Dall sheep are frequently sighted among the meadows of the south-facing slopes along this coastline between spring and fall (ADNR, 2011). Ewes seek protection among the most rugged cliffs of their spring range to give birth to lambs which are born in late May or early June. Lambs are usually weaned by October, before the breeding season occurs in late November and early December. After the breeding season, adult rams join herds of ewes and lambs for winter (ADFG, 2015a).

The most recent extensive survey of the Dall sheep population on the Kenai Peninsula (GMUs 7 and 15) was conducted in 1992, and provided a population estimate of 1,600 sheep (Herreman, 2014a). Since then, aerial sheep counts conducted between 2008 and 2012 have resulted in a population trend of 645 to 751 sheep (Herreman, 2014a). An aerial survey of the Chugach Mountains (GMU 14C) in RY11 counted 1,051 sheep (Coltrane, 2014a). The annual harvest in GMUs 7 and 15 between RY08 and RY 12 has averaged 9 rams (Herreman, 2014a), while 13 sheep were harvested in GMU 14C during RY12 (Coltrane, 2014a)

3.2.4.13. Mountain Goat

Mountain goats are found in the Cook Inlet area in the mountains on the north side of Turnagain Arm, in the Kenai Fjords area of the Kenai Peninsula, and on Kodiak Island (ADFG, 1985, 2016e) - a population originating from animals (11 females and 8 males) captured on the Kenai Peninsula in 1952 and 1953 (Woodford, 2013). Primarily an alpine species (Festa-Bianchet, 2008), in coastal areas goats migrate from summer alpine ranges to winter ranges at or below tree line (ADFG, 2016), utilizing forested coastlines during heavy snow events, and south-facing slopes during the spring (Westing, 2014).

Mountain goats are generalist feeders consuming alder, rhizomes, fern shoots and newly-emergent sedges and forbs in summer, and subsisting on a more limited winter diet based primarily on availability of food (ADFG, 2016; Westing, 2014). Fecundity of mountain goats is lower than other ungulates, with females not reaching maturity until about 4 years of age and typically giving birth to only one kid in mid-late May after a gestation period of approximately 180 days (ADFG, 2016).

The mountain goat population of GMU 6 is estimated at between 3,500 and 4,000 animals, with an average annual harvest of 66 goats (Westing, 2014). In GMUs 7 and 15 (Kenai Peninsula) the goat population decreased 30 to 50% between the early 1990s and 2006, prompting the closing of some areas to hunting and a reduction in the number of permits issued. Surveys conducted in 2013 resulted in a count of 1,322 mountain goats on the Kenai Peninsula (Herreman, 2014b). Two possible causes of continued population declines in some areas of the peninsula are increased winter recreation and consistent helicopter traffic (Herreman, 2014b). A recent study found no evidence that mountain goats habituate to disturbance from helicopters (Côté et al., 2013). As is the case with many other species of ungulates, winter is a stressful period for mountain goats, with the highest mortality experienced at that time of year (Herreman, 2014b). The introduced population on Kodiak Island is estimated at approximately 2,390 animals based on aerial surveys conducted between July and August 2013 and supports an annual harvest of approximately 50 to 150 animals (Svboda and Crye, 2014b). The mountain goat population of GMU 14C (Chugach Mountains) appears to be stable or increasing, with an estimate of 764 animals based on aerial surveys conducted in July 2011, and is currently supporting the management objective of an annual harvest of 25 goats. This population also is subject to disturbance due to winter recreation and helicopter overflights, in particular, dogsled tours and heli-skiing (Coltrane, 2014b).

3.2.4.14. Hoary Marmot

The hoary marmot occurs throughout the Cook Inlet area with the exception of Kodiak, other islands and the western end of the Alaska Peninsula. This species usually is found in alpine areas with talus slopes, boulder fields, and rock outcrops, but can be found at sea level where suitable habitat exists. It dens in the soil under rocks, usually excavating several entrances, a main entrance and several concealed entrances. Rocks overlying the den must be large enough, and accumulated to a depth great enough to provide protection from predators such as wolves, coyotes, and bears that will attempt to dig out the marmots (ADFG, 2008, 2015kk).

Hoary marmots emerge from hibernation in April or early May at which time mating takes place. Three to eight young are born in late spring or early summer, in an underground den, from which they emerge at around six weeks of age. Offspring remain with their parents for two years before dispersing. The hoary marmot is an herbivore, feeding on grasses, flowering plants, berries, roots, mosses, and lichen, and will feed on favored plants rather than those that may be more abundant/ They are most active in early morning and late afternoon (ADFG, 2015a). Marmots return to their dens in September to begin hibernation, plugging the tunnel leading to the nest chamber with vegetation, dirt, and feces in order to protect themselves from the cold (ADFG, 2008).

Alaska's population of hoary marmots is considered stable, and they are managed as a furbearer with no closed season or bag limit (ADFG, 2015a). A possible subspecies, *Marmota caligata sheldoni*, endemic to Montague Island, with the exception of one relatively recent sighting, has not been collected or recorded since the early twentieth century (Lance, 2002).

3.2.5. Birds

This section discusses the birds that use the Cook Inlet area as breeding, feeding, and wintering habitats, or as migratory corridors. Five taxonomic and ecological groups are presented: passerines, raptors, seabirds, waterfowl, and shorebirds (Table 3.2.5-1). Species of these bird groups fly across Cook Inlet during spring and fall migrations, some staging, stopping, or molting in the area as well. Some species of all of these groups also breed and rear their young in coastal Cook Inlet habitats as well.

The discussion in this section includes a general overview of the groups of non-listed species of birds, federally listed species, and designated IBAs with ranges within proposed Lease Sale Area.

3.2.5.1. Non-ESA Listed Species

Alaska supports a diverse and complex marine and coastal bird community consisting of >505 naturally occurring species in 65 families and 20 orders (University of Alaska, 2015), with 247 species having been recorded in the Kodiak Island Archipelago on the eastern margin of Cook Inlet (MacIntosh, 2009). Cook Inlet provides an important resting and staging area for migrating birds, as well as breeding and nesting habitat for >100 species of marine and coastal birds (waterfowl, shorebirds, and seabirds) (ADNR, 2009a). Additionally, the area supports several large seabird colonies such as those on the Chisik and Gull Islands in Cook Inlet, the Barrens Islands, and the Kodiak Island group (Stephensen and Irons, 2003). Information on the locations, sizes, and species compositions of seabird colonies in Cook Inlet is available from the North Pacific Seabird Colonies online database (Seabird Information Network, 2015; USFWS, 2012a). Additional information regarding the migratory behavior of birds in Alaska can be found at the USFWS Migratory Bird Management website (USFWS, 2010b).

Bird species within the same family often share common physical and behavioral characteristics and will be presented briefly by taxonomic families (groups) rather than as individual species. Table 3.2.5-1 provides examples of birds from each group known to occur, or having the potential to occur, in lower Cook Inlet. Shared behavioral characteristics result in a similar potential to be affected by oil and gas activities in the Cook Inlet proposed Lease Sale Area.

Detailed information on species groups utilizing Cook Inlet can be found in Agler et al. (1995), Gill and Tibbitts (1999), and Piatt (2002), while more recent information can be found in ABR, Inc. (2012), Day et al. (2005), Ulman (2012), and URS Corporation (2006).

Table 3.2.5-1. Descriptions of Taxonomic Groups of Birds Occurring in and Adjacent to the Cook Inlet Lease Sale Proposed Lease Sale Area.

Ecological Group	Order	Common Names of Representative Taxa	Description
Landbirds	Passeriformes and Apodiformes	Perching Birds (e.g., warblers, sparrows, flycatchers, swallows, chickadees)	Passeriformes include several distinctly different life history strategies in the Cook Inlet area: large flocks of nocturnally-migrating songbirds pass through the area during migration (many staying locally to breed); many small songbirds (e.g., chickadee sp., redpoll) are common year-round residents; and larger corvids (northwestern crow and common raven) are important year-round scavengers and predators. Apodiformes are hummingbirds, with one species commonly breeding in the Cook Inlet area.
	Coraciiformes	Belted kingfisher	Relatively small birds that plunge-dive for fish in sheltered waters, including coastal bays and marshes. Non-colonial birds that nest in burrows along earthen banks in the proposed Lease Sale Area, and are found there year-round (Walton, Gotthardt, and Fields, 2012).
Raptor and Owl	Falconiformes	Falcons	Feed primarily on other birds captured in flight, including ducks. Some species are found year-round in the proposed Lease Sale Area. Territorial birds that nests along river bluffs and cliffs. Four species of falcons breed in Alaska, including gyrfalcon, peregrine falcon, American kestrel, and merlin. Merlin, a small falcon, is particularly common in Cook Inlet and found in the area year round.
	Accipitriformes	Hawks and Eagles (e.g., bald eagle, northern goshawk, osprey)	Bald eagle found in proposed Lease Sale Area year-round; preys on fish, ducks, small mammals, and carrion; territorial nester in trees close to the water; common bird in the Cook Inlet proposed Lease Sale Area year-round, with the highest nest densities occurring outside the proposed Lease Sale Area, in and along the southern shore of Kachemak Bay (ADNR, 2009a).
	Strigiformes	Owls (e.g., great horned owl, great grey owl, northern hawk-owl, short-eared owl, and snowy owl)	Found in proposed Lease Sale Area year-round (except for short-eared owl); prey on small mammals, birds, and even fish; nest in forested areas (great horned owl, great grey owl, and northern hawk-owl), on open tundra (snowy owl), and in open country including marshes, muskegs, tundra, and prairies (short-eared owl).
Seabird	Charadfriiformes	Jaegers	Three species of pelagic, gull-like birds, coming to land only to nest. Regularly occur in proposed Lease Sale Area during summer and during migration, and can be found over pelagic and coastal waters in winter. Feed by stealing from, scavenging, or directly preying on other birds and eggs.
	Charadfriiformes	Gulls and Terns	Gregarious. Nest colonially on islands and rocky coasts in proposed Lease Sale Area; found in area year-round. Gulls omnivorous and opportunistic; terns plunge-dive small prey from water surface.
	Charadfriiformes	Murres, Murrelets, Guillemots, Auklets and Puffins	Pelagic, coming to land only to nest colonially. Dive for fish and crustaceans; ungainly on land. Nest colonially on islands and coastal slopes in proposed Lease Sale Area; some species remain through the winter.
	Podicipediformes	Grebes	Waterbirds that breed on freshwater lakes and ponds during the summer and spend the rest of the year on coastal marine waters. Dives from surface for fish and aquatic invertebrates. Nest as isolated pair or in small colonies.
	Procellariiformes	Fulmars, Petrels, and Shearwaters	Highly pelagic and aerial species, coming to land only to nest. Found year-round in proposed Lease Sale Area. Feeds from water surface or using shallow dives.
	Procellariiformes	Storm-petrels	Small pelagic birds primarily found well offshore but come to land for nesting in cliffside burrows from April to June (Drummond and Leonard, 2009). Plucks food or skims oily fat from water surface. Colonial nesters. Found in proposed Lease Sale Area year-round.
	Pelicaniformes	Cormorants	Waterbirds that sit and swim on the water and dive for fish. Nest colonially in proposed Lease Sale Area; found there year-round.

Ecological Group	Order	Common Names of Representative Taxa	Description
Waterfowl	Anseriformes	Sea ducks, Ducks, Mergansers, Geese, and Swans	A large and diverse family using a variety of habitats including coastal ponds, bays, saltmarshes, rivers, and open ocean. Species feed by dabbling or diving; some have specialized diets. Found in proposed Lease Sale Area year-round.
	Gaviiformes	Loons	Somewhat large, territorially-breeding waterbirds that dive for fish. Leave water only to nest by late May. Present in proposed Lease Sale Area year-round. During fall migration, some loons congregate on large inland lakes before flying to coastal wintering areas. Loons, such as the common loon, are found on lakes throughout the Cook Inlet area during the summer, and they winter offshore and along the coast from the Aleutians to Baja California (ADNR, 2009a).
	Gruiformes	Sandhill crane	Large, long-legged birds; breeds in salt marshes and feeds in agricultural fields in proposed Lease Sale Area. Occurs in small groups to groups of several hundred or more during migration. Feeds primarily on vegetation.
Shorebird	Charadfriiformes	Plovers	Small shorebirds that nest in pairs on beaches and dunes in proposed Lease Sale Area. Pick small prey from intertidal zone. Found in proposed Lease Sale Area in summer and during migration.
	Charadfriiformes	Oystercatchers	Medium-sized shorebirds specialized for consuming mussels and other mollusks. Nest in pairs on islands. Nests in proposed Lease Sale Area and found there year-round.
	Charadfriiformes	Sandpipers, Turnstones, Godwits, Curlews, and Phalaropes	A diverse family of birds using a variety of habitats including beaches, dunes, mudflats, salt marshes, rocky coasts, and, most unusually, in the case of phalaropes, open water. Short-billed species pick prey from ground or water, while larger-billed species probe into mud or sand. Many species pass through during migration and a few breed in the proposed Lease Sale Area. Rock sandpiper remains in coastal areas through the winter, and red and red-necked phalaropes may be found in open water year-round.

Passerines

Passerines are also known as perching birds, and year-round Cook Inlet residents range in size from the golden-crowned kinglet (*Regulus satrapa*) to the common raven (*Corvus corax*). The Cook Inlet area supports large numbers of passerine species that utilize the area as a stopover location during their largely nocturnal migrations (Day et al., 2005), and as a summer breeding or year-round residence. At least 32 species of passerines have been recorded in the tidal and freshwater marshes, bogs, and other wetland habitats *of* the Kenai lowlands where on-shore pipeline transport of oil production from the Proposed Action is expected (Rosenberg, 1986). Species breeding in this wetland area include rusty blackbird (*Euphagus Carolina*), which is undergoing a steep and chronic range-wide decline (Greenberg, et. al., 2011). Other migrant passerines commonly found breeding in the Kenai lowlands include neotropical migrants like alder flycatcher (*Empidonax alnorum*) and bank swallow (*Riparia riparia*); and temperate and short-distant migrants such as Savannah sparrow (*Passerculus sandwichensis*), tree swallow (*Tachycineta bicolor*), and white-crowned sparrow (*Zonotrichia leucophrys*). Blackpoll warbler (*Setophaga striata*) and olive-sided flycatcher (*Contopus cooperi*), two migrant passerines that have been identified as sensitive species of concern in southcentral Alaska by the State of Alaska (ADFG, 2015a) also breed in the Kenai lowlands (Morton, 2013).

Raptors and Owls

Raptors and owls are all predators, although some, most notably the bald eagle (*Haliaeetus leucocephalus*), utilize other feeding methods as well, such as scavenging. Two of the most frequently observed coastal raptors in the proposed Lease Sale Area are the bald eagle and the peregrine falcon (*Falco peregrinus*) (ADNR, 2009a). While many of the other Alaskan birds of prey hunt birds and small mammals in terrestrial habitats, bald eagles are primarily fish-eaters and may forage in coastal freshwater and saltwater habitats. Bald eagles are common in Cook Inlet. Falcons prey on other birds including seabirds, waterfowl, and shorebirds. The bald eagle is a breeding, year-round resident along the coasts of Cook Inlet and Shelikof Strait, and some species of falcon such as Peale's peregrine falcon (*F. p. pealei*) overwinter in Alaska. Russel (2005) noted that Peregrine falcon has become established as a leading predator of migrant passerines on platforms in the Gulf of Mexico.

Seabirds

Seabirds spend most of their lives at sea, including feeding, resting, and sleeping, coming to land only to nest (USGS, 2015). Thirty-eight species of seabirds with an estimated 40 to 50 million individuals breed in Alaska, and an additional 40 to 45 million seabirds that breed outside of Alaska spend the austral winter feeding in Alaskan waters (USFWS, 2009a). Seabirds generally feed on localized concentrations of prey in single species or mixed species aggregations. Modes of prey acquisition include picking from the sea surface, shallow diving below the sea surface, and diving to depths of several meters (Shealer, 2002). Common seabird species found in marine waters of the proposed Lease Sale Area include common murre (*Uria aalge)*, black-legged kittiwake (*Rissa tridactyla)*, and fork-tailed storm-petrel (*Oceanodroma furcata)*. Glaucous-winged gull (*Larus glaucescens)*, tufted puffin (*Fratercula cirrhata)*, and black-legged kittiwake have some of the most abundant colonies in the vicinity (Seabird Information Network, 2015). Marbled murrelet (*Brachyramphus marmoratus)* and Kittlitz's murrelet (*B. brevirostris),*also regularly use pelagic and nearshore waters of Cook Inlet, and have been identified as "endangered," and "near threatened," respectively, on the International Union for Conservation of Nature (IUCN) Species of Concern List (ADFG, 2015a).

The lower Cook Inlet has been shown to be an important area for seabirds in Alaska (Piatt, 1994) with the east side of lower Cook Inlet being a particularly productive and important habitat (Piatt and Harding, 2007). Kachemak Bay is lower Cook Inlet's primary bird wintering habitat as it remains relatively ice-free, and supports large seabird colonies (Field and Walker, 2003). Kachemak Bay is also an important seabird area during summer and fall (NOAA, 2002a,b).

Many seabird species nest in colonies on islands and bluffs, with nesting sites including beach rubble and boulders, cracks in cliff faces, rocky ledges, burrows in soft soil at a cliff edge, or flat ground (USGS, 2015). Important seabird nesting sites in Cook Inlet include Chisik and Duck Islands, located near Tuxedni Channel, and Gull Island, located in Kachemak Bay outside the proposed Lease Sale Area (USGS, 2015), and the Barren Islands and Shuyak Island, located south of the proposed Lease Sale Area (Piatt, 1994).

Waterfowl

Waterfowl, including dabbling ducks (e.g., mallard (*Anas platyrhynchos)*, northern pintail (*A. acuta*), American green-winged teal (*A. crecca carolinensis*)), diving ducks (greater scaup (*Aythya marila)*), and geese (e.g., greater white-fronted goose (*Anser albifrons*), Canada goose (*Branta canadensis*)) utilize coastal marshes in Cook Inlet as staging and resting areas during migration (Marks and Fischer, 2013; ADFG, 1994), and as breeding habitats. Sea ducks (e.g., long-tailed duck (*Clangula hyemalis)*; common eider (*Somateria mollissima);* surf scoter (*Melanitta perspicillata)*, white-winged scoter (*M. deglandi)*, and black scoter (*M. Americana)* and other related waterbirds feed and rest and sometimes molt (e.g., red-breasted merganser (*Mergus serrator*) within nearshore and inshore coastal waters once breeding is complete (or failed, or even during breeding, in the case of some species that breed in close proximity to the ocean, and for the males of many waterfowl species) (Larned, 2005). Black scoter has been identified as "near threatened" on the IUCN Species of Concern List, and Alaska supports 100% of its breeding population, as it does those of long-tailed duck, all the eider species, and the other scoters (ADFG, 2015a).

Waterfowl typically form large flocks and often are observed in large rafts (dense groups) on the sea surface during the fall staging and molt periods. Other diving ducks are gregarious and mainly are found in freshwater or estuarine environments, although species such as the greater scaup move to marine environments during the winter. Depending on species, they feed on fish, mollusks, and small invertebrates (Sibley, 2000).

Areas along the western coast of Cook Inlet including the Susitna Flats, and Trading and Redoubt Bays are especially important spring migration areas for waterfowl from mid-April through mid-May (NOAA, 2002c). Additional areas of importance during the spring migration are Kenai and Kasilof Rivers, and Chickaloon Bay (NOAA, 2002c). In summer months (June to August), waterfowl continue to use the areas described in the spring but their numbers begin to decline (NOAA, 2002a). Species molt annually between mid-June and mid-August; waterfowl are considered particularly vulnerable during the molting period (NOAA, 2002a). In the fall, between September and November, waterfowl disperse, but smaller groups can be found on Kalgin Island and at the mouth of the Kasilof River (NOAA, 2002b). By winter (December to March), waterfowl mostly have moved away from Cook Inlet. However, overwintering populations and early spring migrants are found in nearshore waters from areas just north of Anchor Point to the southern shores of Kachemak Bay (NOAA, 2002d).

Shorebirds

Shorebirds utilize coastal environments for nesting, feeding, and resting. The Cook Inlet area is important for shorebirds as a stopover site during migrations (e.g., western sandpiper (*Calidris mauri*) and dunlin (*C. alpine*)), and as a wintering location for the rock sandpiper (*C. ptilocnemis*) – the only known shorebird to overwinter in the area (Ruthrauff, Gill, and Tibbitts, 2013). Including upper and lower Cook Inlet south to Tuxedni Bay, Gill and Tibbits (1999) recorded the presence of 28 species of shorebirds over all seasons. Shorebirds that breed in the Cook Inlet area, such as black oystercatcher (*Haematopus bachmani*), rely on the shorelines adjacent to the proposed Lease Sale Area for most of their life functions, and even species which may nest inland (e.g., Hudsonian godwit (*Limosa haemastica*), lesser yellowlegs (*Tringa flavipes*)) often travel to the shore to feed (Gill and Tibbits, 1999). The notable exceptions are phalaropes: red phalarope (*Phalaropus fulicarius*) and red-necked phalarope (*P. lobatus*) are shorebirds that commonly forage in nearshore and pelagic waters when not breeding in freshwater wetlands. Phalaropes also commonly use Cook Inlet tidal flats June – August (Rosenberg, 1986).

Gill and Tibbitts (1999) determined that intertidal habitats of Cook Inlet were particularly important to shorebirds from late autumn to early spring: for example, the area hosts a large percentage of the Pacific flyway population of dunlin during spring migration, and virtually the entire population of the nominate race of the rock sandpiper (*C. p. ptilocnemis*) overwinters there. Important shorebird areas include southern Redoubt Bay and Tuxedni Bay during the spring (ADNR, 2009a; Gill and Tibbitts, 1999) while Kachemak Bay supports >100,000 shorebirds annually including yellowlegs, sandpipers, godwits, dowitchers, and phalaropes. For example, the marbled godwit subspecies (*Limosa fedoa beringea*), which has a global population of only about 2000 birds, breeds exclusively on the Alaska Peninsula, and is identified as “vulnerable” on the NatureServe list of Global Concern (ADFG, 2015a), has been sighted in recent years during spring migration in Kachemak Bay. In the fall, the Susitna Flats is a particularly important area for species that migrating through the area such as western sandpipers and dunlin, and for breeding and migrating Hudsonian godwits, greater yellowlegs (*T. melanoleuca*), solitary sandpipers (*T. solitaria*), and short-billed dowitchers (*Limnodromus griseus*) (ADNR, 2009a; Gill and Tibbitts, 1999). Additionally areas of shorebird concentrations include Trading Bay and the marsh flats of the Matanuska, Knik, Susitna, and little Susitna Rivers (NOAA, 2002a, 2002b, 2002c, and 2002d). Distribution of shorebirds in Cook Inlet is related to food availability on the tidal flats where the birds feed on various invertebrates, particularly small bivalves, and vegetation (Gill and Tibbitts, 1999).

Migration and Seasonal Distribution

Birds migrating to and from breeding areas in interior Alaska, the North Slope, and areas on the west coast of Alaska utilize a route through Cook Inlet. Birds belonging to the waterfowl and raptor groups migrate primarily during the day, while birds of other groups (passerine) do so primarily at night. Migratory birds and their nests are protected under the Migratory Bird Treaty Act of 1918. Many of the birds present in Cook Inlet use the Pacific Flyway, which extends from eastern Siberia through Alaska and along the west coast of the Americas to Tierra del Fuego (Birdnature, 2015). During migration, stopover areas play a vital role in the accumulation of fat reserves that are needed for the substantial amount of energy expended by all species (Brown et al., 2001; McWilliams and Karasov, 2005). Large seasonal aggregations of waterfowl and shorebirds use the coastal wetlands and bays along Cook Inlet as these areas provide important stop-over and staging habitats for migratory species to re-fuel after an energetically demanding part of their migrations, and to prepare for the next stage.

Annual use patterns in Cook Inlet are characterized by the sudden and rapid arrival of very large numbers of birds in spring, typically in early May, followed by an abrupt departure in mid to-late May. Highest avian species diversity and density typically occurs in the spring months (April to May) in Cook Inlet when large numbers of waterfowl and shorebirds migrate through the area. Gill and Tibbitts (1999) reported that >150,000 birds were sighted in one day during spring migration while Arneson (1980) recorded densities of >300 birds per km^2 in Tuxedni Bay and >400 per km^2 in southern Kamishak Bay.

Overall, bird density declines in summer (June to August) as most shorebirds and waterfowl disperse to summer breeding and nesting grounds, however, densities of many seabirds (e.g., gulls, cormorants, murres, and puffins) increase in the open waters of Cook Inlet (Arneson, 1980). A study by Agler et al. (1995) found that during the summer the most common seabirds in Cook Inlet were murres, puffins, and murrelets, with shearwaters, fulmars, and storm-petrels as the second most abundant. Seabirds and seaducks are found along the coastline of Cook Inlet in the summer while the inlet provides breeding habitat for migratory waterfowl (Nature Conservancy, 2003; NOAA, 2002a).

Bird densities in the fall months of September and October, when the migration period is lengthier and not as concentrated over a short period as in spring, are one-third to one-half of those observed in spring and summer months (Agler et al., 1995; Arneson, 1980; Piatt, 2002). A study by Day et al. (2005) found that total numbers of birds observed in spring were more than three times as high as those seen in the fall in upper Cook Inlet. The decline after spring is attributed to the departure of gulls and sea ducks, followed by alcids (e.g., murres and puffins) for pelagic waters. Gill and Tibbitts (1999) reported that densities of geese and dabbling duck increase as migrating birds move into the area, and Arneson (1980) reported bird densities exceeding 100 birds per km^2 in areas of Cook Inlet consisting mostly of dabbling ducks, sea ducks, and gulls. Nature Conservancy (2003) reported that Cook Inlet may be used by as many as 1 million migrating waterfowl in the fall.

Although fewer species and lower abundances of birds are present in the winter from November to March, habitats in Cook Inlet still support significant populations of overwintering birds, notably rock sandpipers, waterfowl, and seabirds (Agler et al., 1995; Gill, Tomkovich, and McCaffery, 2002; Larned and Zwiefelhofer, 2001; USFWS, 2013c). Bird densities in Cook Inlet are approximately half those observed in summer (Agler et al., 1995) reflecting the seasonal changes in species composition as many seabirds (shearwaters, gulls, and murres) depart offshore waters. Agler et al. (1995) and Arneson (1980) reported that the most numerous species groups occupying lower Cook Inlet are waterfowl, alcids, gulls, and cormorants in the winter months. Waterfowl densities increase in winter months and sea ducks are the most abundant group; bird densities tend to be higher in eastern Cook Inlet than on the western side (Agler et al., 1995). The rock sandpiper is the dominant avian species in Cook Inlet in the winter (Gill and Tibbetts, 1999), and it appears likely that Cook Inlet mudflats support virtually the entire Bering Sea breeding population of the species (Ruthrauff, Gill, and Tibbitss, 2013; Gill and Tibbetts, 1999).

3.2.5.2. Threatened or Endangered Species

Two species of federally listed endangered or threatened avian species may occur within or adjacent to the Cook Inlet proposed Lease Sale Area (Table 3.2.5-2). Detailed information on the distribution, abundance, and biology of these two species is found in the Cook Inlet Planning Area Oil and Gas Lease Sales191 and 199 Final EIS (USDOI, MMS, 2003), and is summarized below and supplemented with more recent information.

Table 3.2.5-2. Federally Listed Marine and Coastal Bird Species.

Common Name	Scientific Name	Federal Status	Critical Habitat in Proposed Lease Sale Area
Short-tailed albatross	*Pheobastria albatrus*	Endangered	No*
Steller's eider (Alaska breeding population only)	*Polysticta stelleri*	Threatened	No

* = There is no designated critical habitat for the short-tailed albatross.

Short-tailed Albatross (*Pheobastria albatrus*)

General Description

The short-tailed albatross (*Pheobastria albatrus*) is a long-winged pelagic seabird that breeds on a limited number of islands in the North Pacific. It is the largest seabird in the Northern Hemisphere and is one of four species in the genus *Pheobastria*. These birds y spend most of their lives at sea, and travel great distances over the ocean.

Current Status and Critical Habitat

The short-tailed albatross was listed throughout its range in the U.S. as endangered in 2000 in the U.S. (65 *FR* 46643, July 31, 2000). However, no critical habitat has been designated for this species within U.S. jurisdiction. The greatest threat to short-tailed albatross continues to be the potential for volcanic eruptions on Torishima Island, Japan, where the largest breeding colony is located (USFWS, 2014). Other threats include erosion of colony sites during monsoonal rains, incidental bycatch in commercial fisheries, occurrence of parasitic cestodes and nematodes on Torishima, continuing releases of radiation from the Fukushima Daiichi Nuclear Plant, ingestion of plastics, contamination by oil and other pollutants, the potential for habitat usurpation or degradation by non-native species, and the adverse effects of climate change, such as impacts to characteristics of breeding sites, and a northward shift in prey base resulting in a greater expenditure of energy to obtain prey (USFWS, 2014).

Foraging Ecology

Short-tailed albatross feed at or near the surface and have a limited ability to obtain prey at any great depth. They feed primarily on fish, mollusks, and crustaceans in 'hotspots' outside of the proposed Lease Sale Area (Piatt et al., 2006). Surveys conducted by Suryan et al., (2006) revealed that non-breeding short-tailed albatross forage in oceanic areas characterized by environmental conditions likely to result in areas of enhanced biological productivity or prey aggregations of prey (Suryan et al., 2006).

Life-History

Short-tailed albatross are long lived (to ~50 years), and slow to mature. Breeding begins around the age of 5 or 6 (USFWS, 2009b). Females lay one egg each year. Males and females alternate incubating and foraging. Survival rates for adults and post-fledgling juvenile/subadults are high, and breeding success (the percent of eggs laid that result in a fledged chick) has varied between approximately 60 and 70% in recent years (USFWS, 2009b).

Distribution and Abundance

Albatross are pelagic seabirds that spend their lives at sea. The largest nesting colony is Tsubamezaki, located on the Japanese island of Torishima, where >70% of the short-tailed albatross breeding population occurs (USFWS, 2014). Other sites are on the Senkaku and Bonin Islands, Japan. Overall, the number of breeding pairs has increased from 450 to 500 in 2008, to >750 in 2013 (USFWS, 2014). In the U.S., successful breeding activity has been confined to Midway Atoll, where a single pair has nested since 2010 (USFWS, 2014). The world population is currently estimated to be 4,354 birds and population is increasing at a rate of between 5 and 9% per year (USFWS, 2014). These birds nest on isolated, windswept, offshore islands, with restricted human access (USFWS, 2014).

Non-breeding individuals, especially juveniles, are relatively frequent visitors to U.S. waters, including the northern Gulf of Alaska, Aleutian Islands, and Bering Sea, where they may occur throughout the year (USFWS, 2014). Within their range, this species should be considered a “continental shelf-edge specialist” rather than a coastal or nearshore species (Piatt et al., 2006) and therefore these birds are not expected to occur in the Cook Inlet Planning Area.

Steller’s Eider (Polysticta stelleri)

General Description

The Steller’s eider (*Polysticta stelleri*) spends most of the year in nearshore marine waters and is the smallest of the four eider duck species. It nests in Arctic and subarctic tundra, feeds by dabbling and diving, and in Alaska it moves to primarily nearshore marine waters in the vicinity of the Alaska Peninsula to molt and then winter.

Current Status and Critical Habitat

This species breeds in the Arctic, and the Alaskan breeding population was listed as threatened in 1997 (62 *FR* 31748, June 11, 1997). In 2001, four units in the marine waters of southwest Alaska on the north side of the Alaska Peninsula were among the areas designated as critical habitat for the Steller’s eider (66 *FR* 8850, February 2, 2001), but no critical habitat has been designated within or adjacent to the proposed Lease Sale Area.

The Alaska breeding population was listed due to a contraction in its range. Factors that have been identified as possibly affecting the range contraction and population decline of Steller’s eider in Alaska include increased predation on breeding grounds, subsistence hunting, unlawful harvesting, ingestion of spent lead shot, habitat loss or degradation, impaired water quality, collisions with anthropogenic structures, and exposure to contaminants (BirdLife International, 2015; USFWS, 2002; USFWS, 2011; BirdLife International, 2015).

Foraging Ecology

Steller’s eiders forage in shallow, nearshore areas feeding primarily on marine invertebrates such as mollusks and crustaceans (USFWS, 2002), and have been found in Norway to rely on mobile crustaceans to a greater extent than other sea ducks (Bustnes and Systad, 2001). They have recently been found to use deep water (>10m) habitats at night between December and April as well, but it is as yet unknown whether this is related to feeding or resting (Martin et. al., 2015). On breeding habitats, Steller’s eiders primarily eat insect larvae and aquatic plants. A study of the diet of Steller’s eiders indicated that bivalves, especially blue mussels (*Mytilus edulis*) and clams (*Macoma balthica*), and gammarid and other amphipods were primary food items (Petersen, 1981). Petersen (1981) also found that eiders fed by both dipping their heads in shallow water and by diving for prey. They spent more time dipping during low tides. They forage singly or in large flocks that often dive and surface in unison (USFWS, 2002).

Life-History

Steller’s eiders can live approximately 20 years, and first breed at 2 to 3 years of age. They nest in the terrestrial environment, but they spend the majority of the year in shallow, near-shore marine waters. Pair bonding occurs in the winter, and the eiders move to Arctic nesting grounds as the spring sea ice breaks up (mid- to late April) (ADNR, 2009a). They are solitary, not colonial, breeders that prefer to nest on islands or peninsulas in tundra lakes and ponds near the coast. Females generally lay 1 to 8 eggs and males typically depart once incubation begins (Quakenbush et al., 2004). Females incubate the eggs for approximately 24 days (Quakenbush et al., 2004) until hatching, and young birds are capable of flight within 5 to 7 weeks.

After breeding, Steller’s eiders move to marine waters where they undergo a complete molt and remain flightless for approximately 3 weeks (Petersen, 1981). Molting for the species lasts from late July until late October, with subadults molting first, followed by adult males, and then adult females (Petersen, 1981). After molting, substantial numbers of Steller’s eiders remain in lagoons, particularly on the north side of the Alaska Peninsula in winter, until freezing conditions force them out (Larned, Stehn and Platte, 2006; Rosenberg et al., 2014; USFWS, 2002). While many of the birds disperse to the Aleutian Islands, others move to the south side of the Alaska Peninsula, Kodiak Island, and lower Cook Inlet for the remainder of the winter.

Distribution and Abundance

The majority of the Steller's eider nests in northeastern Siberia, with possibly <1% breeding in Alaska (USFWS, 2011). Two breeding populations are recognized in Arctic Russia (one that winters in the north Atlantic, and one that winters in the north Pacific), and one in Alaska. The Alaskan breeding population primarily nests on the Arctic Coastal Plain (ACP) of the North Slope near Barrow (ADFG, 2016), and will nest on the Yukon-Kuskokwim Delta in extremely rare occasions. Steller’s eiders breed in depressions on grassy edges of tundra lakes and ponds, or within drained lake basins. Although they nest in terrestrial environments, they spend the majority of their year in marine waters. Previously thought to generally confine themselves to shallow waters (<10 m (30 ft) in depth) within 400 m (1,300 ft) of shore, unless the shallows extend farther offshore into bays and lagoons (USFWS, 2002), Martin et.al. (2015) has found that wintering Steller’s eiders commonly are found in water >10m in depth in offshore habitats in southwest Alaska during December through April, particularly during night.

From late August to early October, dense flocks of Steller’s eiders undergo flightless wing molt in shallow estuaries, lagoons, and embayment in southwest Alaska, including Cook Inlet, with the highest numbers occurring in Izembek Lagoon and Nelson Lagoon north of the Alaska Peninsula. Rosenberg et al. (2014) estimates that approximately 2,500 Steller’s eiders undergo molt in Kamishak Bay. From November to April, the birds are found wintering in flocks in shallow, nearshore marine waters along both sides of the Alaska Peninsula, and in smaller numbers along the eastern Aleutian Islands, the Kodiak Archipelago, and lower Cook Inlet (65 *FR* 13262, March 13, 2000; Martin, et. al., 2015). Both the Russian-Pacific breeding and Alaskan-breeding (i.e., the ESA-listed birds) populations molt and winter in southwest Alaska waters, and current studies have shown little evidence of population segregation at this time, except for possibly some preference for Kuskokwim Shoals for Alaska breeders (Martin et. al., 2015; ADNR, 2009a; USFWS, 2002). Cook Inlet is the easternmost extent of the molting and winter range for Steller’s eider, where the species regularly occurs in relatively nearshore waters and bays. Steller’s eiders are present in Cook Inlet between late July to mid-March, with numbers reportedly peaking in January - February (Rosenberg et.al., 2014; Larned, 2006; Martin et. al., 2015).

A 2011 USFWS aerial survey of the Steller's eider spring migration staging in southwest Alaska estimated the Pacific wintering population (comprised of the Alaska-breeding population and the Russia Pacific population) to be about 74,369 birds, and to average 81,453 between 1992-2011 (Larned, 2012a). Late sea ice dispersal and weather-impacted survey flights were believed to possibly have influenced the low 2012 estimate of 59,638 birds (Larned, 2012b). In Cook Inlet, Steller's eider regularly winter along both the eastern coast, where the population between Clam Gulch and Kachemak Bayhas been estimated at 1,499; and the western coastline from Tuxedni Bay to Cape Douglas with as many as 4,284 surveyed (Larned, 2006), resulting in a Cook Inlet estimate of 5,783. Because the Alaskan-breeding population is much smaller than the Russian-breeding population, the percentage of the birds that overwinter in the proposed Lease Sale Area that are from the Alaskan-breeding (i.e., ESA-listed) population is also expected to be low. It is not possible, however, to distinguish between the two populations on the wintering grounds, and, furthermore, it is believed that at least half, and possibly most, of the Alaska-breeding birds, winter in southwest Alaska waters (USFWS, 2015; Martin et. al., 2015). Tracking data has given little indication that the Alaska-breeding population segregates from the Russia-breeding population in winter (Martin et al., 2015). USFWS has made an assumption that 0.8% of all Steller's eiders occurring on the molting and wintering grounds in Alaska are from the listed Alaska breeding population (USFWS, 2015). This estimate is derived by taking an ACP-breeding bird estimate of 576 (Stehn and Platte, 2009), adding one for the extremely limited Y-K Delta population, and then dividing by the population estimate of Pacific-wintering Steller's eiders from 2011 (74,369; Larned, 2012a). Thus, 577 ÷ 74,369 ≈ 0.8%, and this puts the number of Alaska-breeding (i.e., ESA-listed) Steller's eiders in Cook Inlet in the tens of individuals (0.008 ÷ 5,783).

Obtaining population estimates for this rare species has been difficult, but substituting with another recent ACP-breeding estimate of 680 birds (based on the average size of the indicated total bird index (204; 90% CI = 124-283) over all years of eider surveys (1989-2012), and an estimated detection rate of 30% (Stehn, Larned and Platte 2013)) yields only a difference of less than 10 more listed birds in Cook Inlet, with the estimated listed population still well under 100, in the tens of individuals.

3.2.5.3. Important Bird Areas

The IBAs Program was established by the National Audubon Society as a global effort to identify and conserve areas that are vital to birds and biodiversity. IBAs are sites that provide essential habitat for one or more species of bird, and include sites for breeding, wintering, and/or migrating birds. IBAs support the following resources (National Audubon Society, 2010; Smith et al., 2012):

- Species of conservation concern (e.g., threatened or endangered species)
- Restricted-ranges species (species vulnerable because they are not widely distributed)
- Species that are vulnerable because their populations are concentrated in one general habitat type or biome
- Species or groups of similar species (such as waterfowl or shorebirds) that are vulnerable because they occur at high densities because of their congregatory behavior

This identification has no regulatory consequences but does provide information on avian habitats of Cook Inlet. The 23 IBA sites designated along the coast, in nearshore waters, or offshore in Cook Inlet (Figure 3.2.5-1) are listed and briefly described in Table 3.2.5-3. The IBA sites include state and global locations and provide important overwintering habitat for some species; provide foraging and resting habitat for a large variety of waterfowl, shorebirds, wading birds, and migrating passerines; provide important breeding grounds for shorebirds; and provide an important migration stop-over for landbirds.

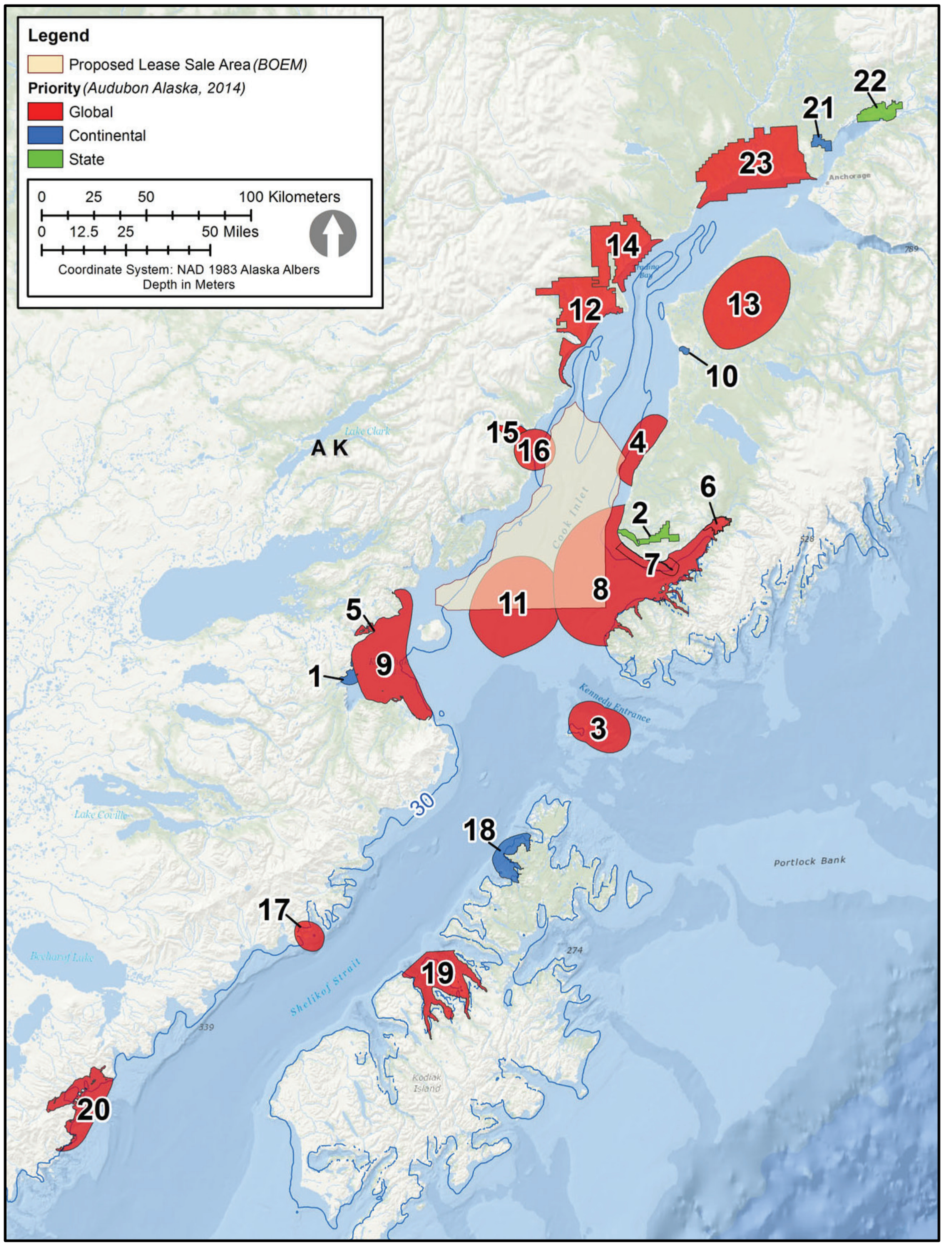


Figure 3.2.5-1. Important Bird Areas (IBAs) in and Around the Proposed Lease Sale Area. *See Table 3.2.5-3 for IBA key to Names and Further Information. (Source: Audubon Alaska, 2014).*

Table 3.2.5-3. Important Bird Areas in or Near the Proposed Lease Sale Area.

IBA	County	Status	Priority	Recognized Importance
1. Amakdedulia Cove	Kenai Peninsula	Recognized	Continental	Seabird nesting colony; summer waterfowl congregation area.
2. Anchor River	Kenai Peninsula	Recognized	State	Migratory passerine concentration area.
3. Barren Islands Colonies	Kenai Peninsula	Identified	Global	Contains 6 seabird nesting colonies, supporting 14 species and more than 400,000 individuals; key species include pelagic cormorant, glaucous-winged gull, black-legged kittiwake, tufted puffin, and fork-tailed storm-petrel.
4. Clam Gulch*	Kenai Peninsula	Recognized	Global	Steller's eider wintering area; black scoter, long-tailed duck, and common eider present. Also a critical habitat area for razor clams.

IBA	County	Status	Priority	Recognized Importance
5. Contact Point	Kenai Peninsula	Recognized	State	Seabird nesting colony for 6 species; spring waterfowl congregation area.
6. Fox River Flats	Kenai Peninsula	Recognized	Global	Spring migration stopover area for 22 species; spring, fall, and winter waterfowl congregation area.
7. Homer Spit	Kenai Peninsula	Recognized	Global	Steller's eider wintering area; rock sandpiper wintering area; spring migration stopover area for shorebirds, including western sandpiper and surfbird; whimbrel, wandering tattler, black oystercatcher, Pacific golden-plover, bristle-thighed curlew, Hudsonian godwit, marbled godwit, bar-tailed godwit, black turnstone, and trumpeter swan present.
8. Kachemak Bay*	Kenai Peninsula	Identified	Global	Kittlitz's murrelet, white-winged scoter, black scoter, pelagic cormorant, marbled murrelet. The area provides seabird and seaduck wintering habitat; waterfowl and shorebird migration stopover habitat; and seabird foraging habitat.
9. Kamishak Bay	Kenai Peninsula	Identified	Global	Breeding habitat for glaucous-winged gull, molting habitat for Steller's eider
10. Kenai River Flats	Kenai Peninsula	Recognized	Continental	Spring staging area for Wrangell Island snow goose; seabird nesting colonies; migrant shorebirds, waterfowl and wading birds also use the area.
11. Lower Cook Inlet 59°N, 153°W*	Kenai Peninsula	Identified	Global	Non-breeding habitat for glaucous-winged gull and provides foraging habitat for seabirds.
12. Redoubt Bay	Kenai Peninsula	Recognized	Global	Supports 70% of Cook Inlet spring migrant shorebirds; waterfowl, including multple species of goose, swan and duck.
13. Swanson Lakes	Kenai Peninsula	Recognized	Global	Trumpeter swan; red-throated loon; one of highest densities of common loon in North America.
14. Trading Bay	Kenai Peninsula	Recognized	Global	Wrangell Island snow goose spring staging area; rock sandpiper nominate race wintering area; spring migrant stopover area for Hudsonian godwit, whimbrel, and American golden-plover; used by red-throated loon.
15. Tuxedni Bay	Kenai Peninsula	Recognized	Global	Fall migration stopover for geese; summer and fall concentration area for scoters; spring migration stopover for long-tailed duck and western sandpiper; black scoter, black oystercatcher, black turnstone, surfbird and whimbrel present.
16. Tuxedni Island Colony*	Kenai Peninsula	Identified	Global	Contains a seabird nesting colony hosting multiple species, including black-legged kittiwake. Provides shorebird migration stopover habitat for western sandpiper; waterfowl migration stopover habitat for Canadian geese; and provides waterfowl molting habitat for surf scoter and white-winged scoter.
17. Amalik Bay Colonies	Kodiak Island	Identified	Global	Contains 3 seabird nesting colonies, hosting 10 species, including red-faced cormorant.
18. Northwest Afognak Island	Kodiak Island	Recognized	Continental	Breeding area for black oystercatcher; nesting and foraging habitat for other shorebirds and seabirds.
19. Uganik Bay and Viekoda Bay	Kodiak Island	Recognized	Global	Contains 14 seabird nesting colonies; breeding area for black oystercatcher and other shorebirds; wintering area for multiple species of seabirds and waterfowl.
20. Wide Bay	Kodiak Island	Recognized	Global	Contains several seabird nesting colonies; waterfowl, including emperor goose and Steller's eider routinely congregate in this area; bald eagle nesting sites present.
21. Goose Bay	Matanuska-Susitna	Recognized	Continental	Spring and fall stopover for waterfowl.
22. Palmer Hay Flats	Matanuska-Susitna	Recognized	State	Spring and fall stopover area for waterfowl.
23. Susitna Flats	Matanuska-Susitna	Recognized	Global	Spring migration stopover area for waterfowl and shorebirds; rock sandpiper (nominate race) wintering area.

Note: * Overlaps with proposed Lease Sale Area.
Source: Audubon Alaska (2014).

Of the 23 sites that have been identified or recognized as IBAs in the Cook Inlet area, Kachemak Bay also has received recognition as a Site of International Importance by the Western Hemisphere Shorebird Reserve Network (WHSRN) because it hosts >100,000 shorebirds on an annual basis

(WHSRN, 2009). The bay includes approximately 515 km (320 mi) of shoreline, with tides of as much as 9 m (30 ft), and provides an abundance of intertidal habitat for the 36 species of shorebird that have been reported from the area.

3.2.6. Coastal and Estuarine Habitats

This section discusses coastal and estuarine habitats of Cook Inlet. Data to support this analysis were obtained from the Alaska Shore Zone Program and the National Wetlands Inventory (NWI). Additionally, the NOAA Environmental Sensitivity Index (ESI), which ranks shorelines according to their sensitivity to oil, the natural persistence of oil, and the expected ease of cleanup after an oil spill, was utilized in analysis. Some ESI factors cause oil to persist in coastal and estuarine areas (USDOI, MMS, 2010). According to the ESI, the most sensitive shoreline types (i.e., sheltered tidal flats, vegetated low banks, salt and brackish-water marshes, freshwater marshes and swamps, and scrub-shrub wetlands) tend to accumulate oil and are difficult to clean, so that oil persists in these coastal and estuarine areas (USDOI, MMS, 2010). These coastal and estuarine areas primarily will be affected if oil reaches them, because these are the most productive areas, and because many species reside in estuaries for at least part of their life cycle, or are dependent on the nutrients exported from estuaries to the shelf. Cook Inlet encompasses a wide range of coastal habitats including along-shore and across-shore areas from the high to the low intertidal zones. Large rock platforms are found throughout Kamishak Bay, while steep rocky shorelines are more common along the eastern shorelines of lower Cook Inlet. Many shorelines of upper Cook Inlet and middle Cook Inlet support extensive salt marsh habitats, as discussed in Section 3.2.6.2.6.

3.2.6.1. Regional Setting

The coastline along much of the northwestern Gulf of Alaska is characterized by mountains with steep topography leading down to an irregular shoreline, indented by many inlets, fjords, bays, and estuaries, including two major estuaries: Cook Inlet and Prince William Sound (Saupe, Gendron, and Dasher, 2005). Cook Inlet is a 370 km (230 mi) long estuarine system that includes Kamishak Bay, Kachemak Bay, and Turnagain and Knik Arms. The shelf system is relatively narrow (typically <100 km (62 mi)), although there are areas where the shelf extends up to 200 km (124 mi) wide, for example, just east of Cook Inlet (Saupe, Gendron, and Dasher, 2005). There are areas where water depth is highly variable and can include sea stacks, underwater canyons, or deep holes as found in the center of Prince William Sound.

Elevated marine beach deposits and wave cut platforms along the western coast of Cook Inlet indicate that this coast is rising. Material dated from Kamishak Bay suggests that the rate of uplift is about 0.5 m (1.6 ft) per century (Saupe, Lindberg, and Schoch, 2012). This uplift is in response to tectonic activity, and possibly in part to isostatic adjustments following deglaciation. Open ocean overlying the continental shelf in Cook Inlet and its associated high-energy coastline comprise the marine system. Marine habitats are exposed to waves and currents of the open ocean, and their hydrologic characteristics are determined by the ebb and flow of the tide (Saupe, Lindberg, and Schoch, 2012). Shallow coastal indentations or bays without high freshwater inflow, and coasts with exposed rocky islands that provide the mainland with little to no shelter from wind and waves are considered part of the marine system in this document because they generally support typical marine biota.

3.2.6.2. Description of Coastal and Estuarine Habitat Types

Supratidal, Intertidal, and Subtidal Communities

Much of Cook Inlet is bordered by extensive intertidal mud and sand flats that grade into equally extensive vegetated tidal and supratidal wetlands. Supratidal, intertidal, and subtidal communities are an important conduit of energy, nutrients, and pollutants between terrestrial and marine environments, and provide resources for subsistence, sport, and commercial harvests. They also are important for recreational activities such as wildlife viewing and fishing.

Marine intertidal habitats consist of rocky shores and unconsolidated shores (beaches, bars and flats). Intertidal flats occur extensively in most coastal regions of Alaska. This habitat often lies seaward of salt marsh areas, at river mouths and deltas, along rocky coasts, or in lagoons. In Cook Inlet, rocky substrates are juxtaposed with sandy beaches and tidal mud flats, ranging from completely protected beaches to those with extreme wave exposure. Expansive tidal marshes and smaller marshes lie at the heads of protected bays and fjords. Tidal flats appear at low tide largely as unvegetated expanses of mud or sand (Field and Walker, 2003). Intertidal flats often are mixed with areas of emergent estuarine wetlands or rocky shores. Many of the largest intertidal flats along Alaska's coastline are associated with major river deltas such as those found on the west side of Cook Inlet.

Rocky Intertidal, Rocky Reef, Bedrock and Boulder Shores

Rocky shores generally are high-energy habitats exposed as a result of continuous erosion by wind-driven waves or strong currents (Federal Geographic Data Committee, 2013). The substrate is stable enough to permit the attachment and growth of sessile or sedentary invertebrates, and attached algae or lichens. Rocky shores usually display a vertical zonation that is a function of tidal range, wave action, and degree of exposure to the sun (Federal Geographic Data Committee, 2013). Most of the rocky intertidal/rocky reef habitat in the area is found on the western side of Cook Inlet. Exposed rocky shores are composed of steeply dipping, vertical bedrock and are exposed to moderate to high wave energy. Similar wave energy also affects exposed wave-cut platforms or low-lying bedrock (Saupe, Gendron, and Dasher, 2005). Gravel, cobble, and/or boulder beaches are typically narrow and steep (NOAA, 1999). This habitat supports a diverse collection of invertebrates and also is an important area for foraging marine birds and mammals.

Mud Flats and Beaches

Cook Inlet intertidal mudflats and beaches are generally categorized as unconsolidated soft-substrate intertidal habitats, including sheltered tidal mudflats, as well as sand, gravel, and cobble beaches, each of which harbors distinct biological communities. Nearshore, and in some embayments, the current slows, and sediments can accumulate and create very wide sand or mud flats that can extend along the coastline for tens of kilometers (or miles (mi)) and be >1.6 km (1 mi) wide in the intertidal zone (Saupe, Gendron, and Dasher, 2005). Mudflats are a common habitat in Cook Inlet and this habitat is important for benthic organisms. These mudflats also provide important stopover foraging habitat for migrating birds.

Unconsolidated beaches are a mixture of sand, gravel, and mud, with occasional cobbles and boulders. There are five "soft" intertidal habitat types: beaches of fine-grained sand, beaches of coarse-grained sand, mixed sand and gravel beaches, exposed tidal flats, and sheltered tidal mudflats (Carmen and Walker, 2003). Beaches dominantly composed of fine-grained sand usually are broad and gently sloping, while those of coarse-grained sand are wide and steep, and are generally associated with river or stream mouths. Mixed sand and gravel beaches contain coarse-grained sands, gravel of varying sizes, and possibly shell fragments.

The nearest landfall of the subsea pipelines from the hub platform would be on the east side of Cook Inlet, through intertidal unconsolidated beaches. Though the location of the landfall would be between Homer and Nikiski, up to 80 km (50 mi) long, (Section 2.4.5. Development Activities, Pipelines), for the purpose of evaluating the onshore wetland impacts, it is assumed the landfall would likely be north of the mouth of the Anchor River and south of the mouth of Deep Creek. With the exception of estuaries (Section 3.2.6.2 Wetlands, Estuarine Wetlands) at the mouth of streams flowing into Cook Inlet, the NWI classified that shoreline habitat as part of the marine system. Marine habitats have salinities exceeding 30 parts per thousand (ppt) and have little or no dilution except outside the mouths of estuaries. It further describes the coast as a high energy coast line with unconsolidated substrates with less than 75% areal cover of stones, boulders or bedrock and less than 30% areal cover of vegetation; general characterized as beaches, bars, and/or flats. The NWI notes the tidal regime of the coast as intertidal habitat, that alternately floods and exposes land surface at least once daily.

Exposed tidal flats are composed of sand and/or gravel, and are associated with lagoons found at the heads of coastal bays. They are exposed to moderate wave and tidal energy and riverine (freshwater) inputs. Sheltered tidal mudflats contain soft mud or muddy sand. They occur at the heads of bays or in estuarine wetlands and are exposed to low wave activity and moderate tidal currents. Intertidal habitats include mixed sand and gravel beaches with mudflats exposed at low tide, as well as occasional hard sand flats at lower tidal elevations (Carmen and Walker, 2003).

Subtidal Communities - Kelp Forests and Eelgrass Beds

Kelp

From the high tide line to a depth of 30 m (98 ft), rocky habitat on the eastern side of Cook Inlet between Archimandritof Shoals and Anchor Point supports kelp forests, split kelp (*Saccharina groenlandica*), and bull kelp (*Nereocystis luetkeana*) (Chenelot and Matweyou, 2001). The majority of the other kelp forests occur further south and out of the proposed Lease Sale Area between MacDonald Spit and Port Graham. Studies conducted in Kachemak Bay indicate that while growth and senescence patterns vary from year to year, aerial kelp canopy cover in the Bay can change from 90% in August to 15% by mid-October (Saupe, Gendron, and Dasher, 2005). Although the extent of kelp forests varies from year to year, kelp contributes primary productivity and habitat complexity to the marine ecosystem (Dames and Moore, Inc., 1979) adjacent to the proposed Lease Sale Area. The seasonal die-off contributes detritus to the ecosystem during low-light winter months, supporting detritivores and upper trophic levels when primary productivity in the water column wanes (Dames and Moore, Inc., 1979).

Eelgrass Beds

Eelgrass beds provide a buffer to tidal erosion and seasonal storms as well as a constant food source for the epibiota. Eelgrass beds contribute primary production to the marine ecosystem, which supports food for foraging fish, birds, and invertebrates. Eelgrass beds also provide important habitat and cover for rearing salmon and shellfish. Eelgrass beds appear along the shorelines of Cook Inlet where sandy mudflats occur in low intertidal and shallow subtidal areas with limited wave exposure (Carmen and Walker, 2003). The eelgrass grows in clusters (also called beds) in low intertidal and shallow, subtidal, sandy mudflats. In the proposed Lease Sale Area, eelgrass distribution is discontinuous, and does not grow as extensively as kelp in other areas of the State of Alaska; the depth to which eelgrass grows is limited by the penetration of light in the water column (Carmen and Walker, 2003). Eelgrass communities are common in protected estuaries, however, the proposed Lease Sale Area does not offer extensive, suitable habitat for eelgrass. This likely is due to high turbidity in the water column, glacial runoff during the summer growth season, and lack of suitable substrate.

Wetlands

Cook Inlet has a great diversity of wetland types as classified by the NWI (Figure 3.2.6-2).

Estuarine Wetlands and Marine Deepwater Habitats

Wetlands and deepwater habitats are defined separately because traditionally, the term wetlands has not included deep, permanent water; however, both must be considered in an ecological approach to classification (Federal Geographic Data Committee, 2013). Deepwater habitats are permanently flooded lands lying below the deepwater boundary of wetlands (Cowardin et al., 1979). Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium in which the dominant organisms live, whether or not they are rooted in, or attached to, the substrate (Cowardin et al., 1979). As in wetlands, the dominant plants are hydrophytes (Federal Geographic Data Committee, 2013); however, the substrates are considered nonsoil because the water is too deep to support emergent vegetation (U.S. Soil Conservation Service, Soil Survey Staff, 1975).

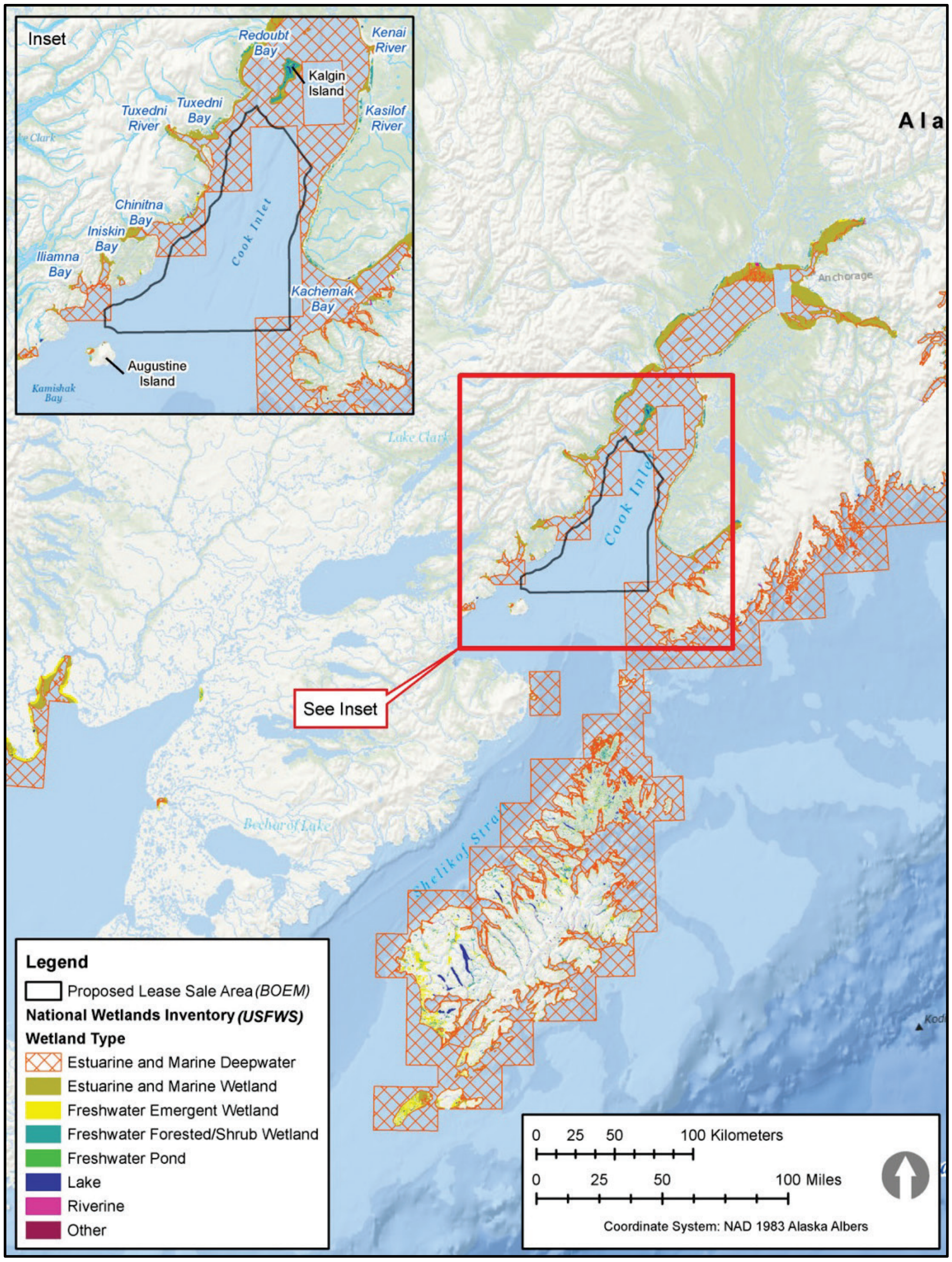


Figure 3.2.6-1. Coastal Wetlands in Cook Inlet. *Created using the National Wetlands Inventory. Metadata may be downloaded from the USWFS website.*

The NWI maps, based upon Cowardin et al. (1979), separate marine and estuarine habitats. However, based on these maps, estuarine and marine deepwater habitats are blended together as one predominant wetland or habitat type in lower Cook Inlet. Estuarine and marine deepwater habitats typically occur between wetland and deepwater habitat in the marine and estuarine systems [and] coincide with the elevation of the extreme low water of spring tide; permanently flooded areas are considered deepwater habitats in these systems (Cowardin et al., 1979). Figure 3.2.6-1 shows the estuarine and marine deepwater habitats extending across nearly the entire upper Cook Inlet; at the time of NWI mapping, USFWS personnel lacked the equipment to check (or ground truth) mapping conducted in deepwater environments (Gene Augustine, BOEM, personal communication).

Estuarine and Marine Wetland Habitats

Estuarine and marine wetland habitats are essential breeding, rearing, and feeding grounds for many species of fish and wildlife. They also perform flood protection, pollution control, and a variety of other important functions (Federal Geographic Data Committee, 2013). These include the eelgrass along the Alaska Peninsula and kelp beds downstream from currents in Cook Inlet, through Shelikof Strait and the Gulf of Alaska. These wetlands are typically found in shallow coastal indentations or bays without significant freshwater inflow, and coasts with exposed rocky islands that provide the mainland with little to no shelter from wind and waves. These habitats are exposed to the waves and currents of the open ocean and the water regimes are determined primarily by the ebb and flow of oceanic tides (Federal Geographic Data Committee, 2013). The distribution of plants and animals in the marine system primarily reflects differences in four factors: (1) degree of exposure of the site to waves; (2) texture and physicochemical nature of the substrate; (3) amplitude of the tides; and (4) latitude, which governs water temperature, the intensity and duration of solar radiation, and the presence or absence of ice (Federal Geographic Data Committee, 2013).

Estuarine Wetlands

The estuarine system consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land (Cowardin et al., 1979). In Cook Inlet, estuarine systems include estuaries and lagoons and are more strongly influenced by their association with land than the marine system. In terms of wave action, estuaries are generally considered low-energy systems (Chapman, 1977), and water regimes and water chemistry are affected by one or more of the following forces: oceanic tides, precipitation, and freshwater runoff from land areas, evaporation, and wind.

Three estuarine wetlands are located along the western coast of lower Kenai Peninsula (east side of Cook Inlet) in the general vicinity of the Proposed Action's subsea pipeline landfall (Section 2.4.5. Development Activities, Pipelines). They include the mouths of Anchor River, Stariski Creek, and Deep Creek. The Anchor River is south of the nearest landfall of the subsea pipelines from the hub platform. North of the nearest landfall of the subsea pipeline is the estuary at the mouth of Deep Creek. Stariski Creek is approximately one-third to midway between the Anchor River and Deep Creek, located about 10 km (6.2 mi) north of the Anchor River, along the 30 km (19 mi) stretch of the lower Kenai Peninsula shoreline between the Anchor River and Deep Creek.

The estuaries at the mouths of Anchor River, Stariski Creek, and Deep Creek are classified by the NWI as estuarine wetlands with deepwater tidal habitats and adjacent tidal wetlands influenced by water runoff with a variable salinity and often semi-enclosed by land; the unconsolidated shore of the adjacent marine-intertidal coastline. Stariski Creek estuary is approximately 1.5 km (1 mi) to 2 km (1.25 mi) long. The semi-enclosure results in a low-energy coastline The NWI indicates each of these wetlands have emergent vegetation that are erect, rooted, herbaceous hydrophytes, excluding mosses and lichens, and present for most of the growing season during most years and remain standing at least until the beginning of the next growing season. It further provided the tidal regime of these estuaries as intertidal; differences include Anchor River's tidal water floods the land surface less often than daily, while Stariski Creek's and Deep Creek's alternately floods and exposed land at least once daily.

There is a pipeline right-of-way with existing pipelines from the lower Kenai Peninsula that crosses under the Anchor River, Stariski Creek, Deep Creek, Ninilchuk River, and the Kasilof River before crossing under the Kenai River estuary on the way to Nikiski. All but the Kenai River crossing is upstream of estuarine waters, in freshwater. The onshore portion of the Proposed Action would follow the same route of the existing pipelines across the Kenai River estuary, first crossing under the Kenai River approximately 4.8 km (3 mi) upstream from the mouth. The NWI characterizes that portion of the river as a deepwater subtidal estuary with continuously submerged substrate and an unconsolidated bottom with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. The river is approximately 250 m (820 ft) wide. The pipeline right-of-way then crosses approximately 125 m (410 ft) of intertidal estuary of unconsolidated substrates with less than 75% areal cover of stones, boulders or bedrock and, less than 30% areal cover of vegetation. Before the pipeline right-of-way connects to upland it crosses an intertidal estuary 2.25 km (1.4 mi) with emergent vegetation dominated by species that normally remain standing at least until the beginning of the next growing season and characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens, according to the NWI. Within the 2.25 km expanse of emergent vegetation is also less vegetated areas of unconsolidated substrate with less than 30% areal coverage and where tidal water alternately floods the land surface at least once daily. A detailed discussion of vegetation and wildlife/habitat uses of the Kenai River estuary, locally known as the Kenai Flats, was accomplished by Rosenberg (1986).

In the upper Cook Inlet area, estuarine intertidal wetland environments consist of expansive mud flats and wide estuarine emergent zones located in Trading Bay, Redoubt Bay, Turnagain Arm, Knik Arm, and near the mouth of the Susitna River (Hall, 1988). The upper Cook Inlet wetlands are one of seven wetland complexes in Alaska designated by the Service as waterfowl habitat areas of major concern (Hall, 1988).

Freshwater Emergent Wetland

Areas such as the sheltered portions of the Alexander Archipelago and lower Cook Inlet have a greater diversity of coastal wetland types. Emergent marshes, unconsolidated shores, and rocky shores often alternate over short distances in these regions (Hall, 1988). The NWI emergent wetland class is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens, that are present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. Freshwater emergent wetlands are found along the western and eastern shores of Cook Inlet adjacent to estuarine coastal habitats. In Cook Inlet, estuarine intertidal wetland environments consisting of expansive mudflats and wide estuarine emergent wetlands are located in Trading Bay, Redoubt Bay, Tuxedni Bay, and Chinitna Bay; the beyond the reach of tidal inundation these wetlands become freshwater wetlands where they are saturated by upland runoff, freshwater streams (including melt water from glaciers), rain, and/or groundwater.

The Proposed Action’s onshore pipeline would cross a number of freshwater emergent wetlands within the existing pipeline right-of-way. Other than crossing below the Kenai River’s estuarine waters, pipeline crossings would be below flowing freshwater portions of Deep Creek, Ninilchik River, Crooked Creek and Kasilof River. These streams would be classified by the NWI as a system of riverine wetlands with temporarily or seasonally flooded, unconsolidated shore and/or emergent wetlands vegetation that are nonpersistent or semi-permanently to permanently flooded aquatic beds or unconsolidated bottom. Most of the emergent wetlands around these streams, as well as in unnamed drainages along the pipeline right-of-way are characterized by the NWI as palustrine wetlands. A review of the NWI maps indicates the palustrine wetlands along the pipeline right-of-way would be persistent vegetated emergent wetlands and scrub/shrub wetlands. Emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens that are present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. Scrub-shrub wetlands includes areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions. The scrub-shrub wetlands along most of the existing pipeline right-of-way are among the various patterned bogs or bog meadows described by Rosenberg (1986) report on wetland types.

Coastal Bays, Islets, Salt and Tidal Marshes, Ponds, Lakes, and Streams

Coastal Bays

Lower Cook Inlet contains several medium to large coastal bays and islets (Figure 3.2.6-1). The bays and islets closest to and surrounding the proposed Lease Sale Area listed in a counter clockwise direction from north include: Trading, Redoubt, Tuxedni, Chinitna, Oil, Iniskin, and Iliamna Bays, Ursus Cove, Bruin, Kamishak, and Kachemak Bays.

Salt Marshes

Salt marshes are highly productive estuarine habitats that support a wide range of animal species, including intertidal invertebrates, fish, birds and mammals (Baird, Field, and Badajos, 2007). Locations of salt marshes in the Cook Inlet region are shown in Figure 3.2.6-2. Salt marshes are characteristically on or near low-energy, nearly level shores close to the mouths of rivers or behind barrier islands and beaches. Salt marshes also typically occur on low wave energy, tidally dominated coasts such as heads of bays, behind spits, and in fringing coastal lagoons. Tidal inundation is important for delivering sediments, nutrients and water to the marsh. A salt marsh is dominated by dense stands of halophytic terrestrial plants such as herbs, grasses, and low shrubs, but plant species diversity is relatively low (Saupe, Lindberg, and Sohoch, 2012). Salt marshes typically show distinct patterns of vertical zonation caused by differences in the frequency of tidal inundation with elevation, and the plants must respond to these differences according to their individual tolerance for salinity and water table levels.

Three Cook Inlet tidal marshes were extensively mapped in 2007: Trading Bay and Redoubt Bay on the western side of Cook Inlet, and Chickaloon Bay on the eastern side of Cook Inlet. The total salt marsh area mapped in the three bays was approximately 7,640 ha (18,880 ac) (Baird, Field, and Badajos, 2007). The three coastal marshes included a wide range of plant community types, dominated by relatively few species. Trading Bay and Redoubt Bay show evidence of ongoing erosion— there were often sudden, several-foot changes in elevation at the upper limit of normal wave activity, thought to have been a result of the 1989 eruption of Redoubt Volcano, and the character of these marshes may be a result of heavy siltation following that eruption (Baird, Field, and Badajos, 2007). These effects resulted in low-marsh areas of limited areal extent transitioning into an extensive high-marsh, with little to no mid-marsh (Baird, Field, and Badajos, 2007). The upper extent of salt marsh vegetation can be difficult to determine, particularly in marshes like Chinitna Bay, Redoubt Bay, and Trading Bay, where salt marshes gradually transition into extensive freshwater marshes (Baird and Field, 2008).

Tidal Marshes

Tidal marshes are important as critical habitats for migratory and resident birds, buffers against shoreline erosion, and sources of organic material - called detritus - for the regional marine ecosystem (Carmen and Walker, 2003). Productivity is higher in tidal marshes than that found in most other ecosystems and forms the basis of estuarine food chains. In Cook Inlet, tidal marshes develop in a variety of places, including at river mouths, behind barrier islands, along spits, and on tidal flats (Carmen and Walker, 2003). Deposition of sediment from rivers form deltas consisting of fine silt, clay, and sand upon which lush communities of salt-tolerant, herbaceous sedges, and succulent, tidal marsh plants develop. This section describes tidal marsh communities found between the mean high watermark and the lower intertidal zone.

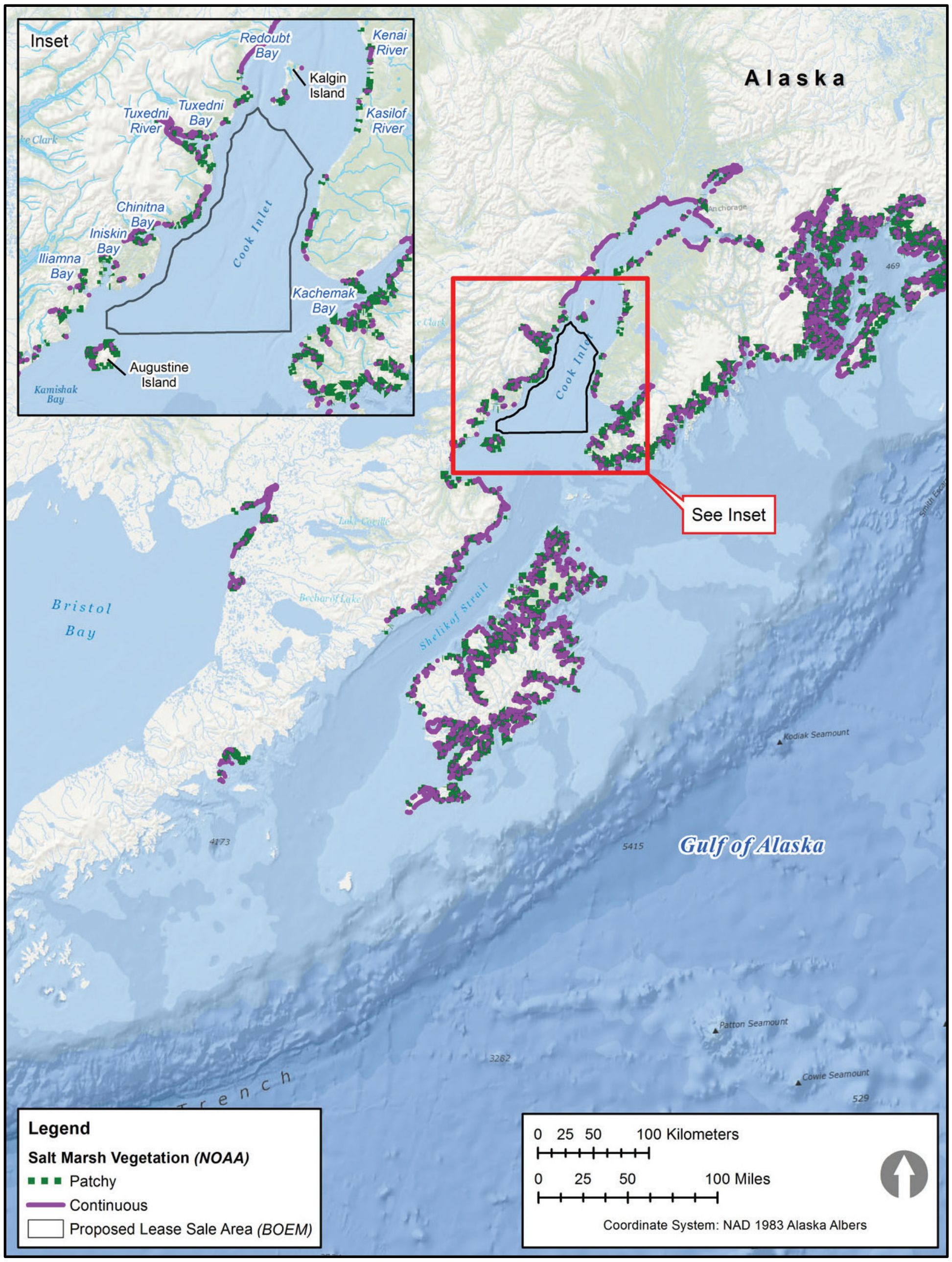


Figure 3.2.6-2. Salt Marshes near the Proposed Lease Sale Area. *Source: Alaska Shore Zone Program.*

Coastal Ponds and Lakes

Coastal lakes can be formed when rapidly circulating beach sediments dam small watersheds and estuaries. Their development is dependent on the amount of sediment transported by waves and currents along the coast, and the amount of freshwater discharge from the watershed. In the winter, when watersheds are typically frozen and river discharge is minimal, waves and currents generated by energetic storms will transport large volumes of beach sediment. In the spring and summer, when freshwater discharge is high and sediment transport is low, the beach dams may be partially or completely destroyed.

An additional three bays were mapped by Baird and Field in 2008: Iniskin Bay, Oil Bay, and Chinitna Bay, all on the western side of Cook Inlet. Tuxedni Bay also was mapped in 1996 (Tande, 1996). The total salt marsh area mapped in the three bays not including Tuxedni Bay was approximately 1,264 hectares (3,124 ac) (Baird and Field, 2008). The three coastal marshes mapped during this effort did not exhibit the erosional characteristics of the western marshes mapped in 2007 (Baird, Field, and Badajos, 2007).

Tidal Streams

Major sediment sources found in Cook Inlet include the Knik, Matanuska, Beluga, and Susitna Rivers which drain into upper Cook Inlet (Saupe, Gendron, and Dasher, 2005). The Kenai River in middle Cook Inlet is also a major sediment contributor (Section 3.1.5.2. Water Quality in Cook Inlet, Stream Load and Suspended Sediment). Heavy sediment loads introduced into upper Cook Inlet are deposited downcurrent and, although these suspended sediment concentrations are high in upper Cook Inlet, their deposition into the upper Cook Inlet and central inlet is thought to be minimal due to scouring by tidal currents (Saupe, Gendron, and Dasher, 2005).

Upper Cook Inlet has a tidal range of approximately 10 m (33 ft), one of the highest in the world. Three major riverine systems, the Knik, Matanuska, and Susitna Rivers, drain into the northern inlet and constitute the largest riverine drainage into the Gulf of Alaska. These freshwater inputs establish density-driven currents that cause a net flow of water along the west side towards the mouth of Cook Inlet and introduce huge amounts of glacial silt downstream into the coastal Gulf of Alaska (Saupe, Gendron, and Dasher, 2005). The southern areas of Cook Inlet include Kamishak Bay on the western side, and Kachemak Bay on the eastern side. These waters in lower Cook Inlet are highly productive, due in part to upwelling of nutrient-rich waters through Kennedy and Stevenson Entrances at the mouth of the inlet.

3.3. Socioeconomic and Sociocultural Systems

Socioeconomic assessment evaluates the relationship between social life and economic activity, and assesses social and economic change on human populations. Socioeconomic assessment of a population within a specific region considers such factors as the sources, availability and distribution of jobs and income; the size and composition of populations; people's reliance on and use of resources; and how people interact, as individuals and in groups.

Sociocultural assessment includes consideration of values, beliefs, customs, practices, and behaviors. These variables are related to socioeconomic elements, and include both current and historic perspectives. Sociocultural assessment elucidates how populations have been and currently are connected to the environment, and how and why daily social action and interaction has occurred, and how it occurs today.

This section of the Draft EIS summarizes various socioeconomic and sociocultural conditions and trends that could be affected by the proposed leasing activity. Potential impacts to the existing environment are discussed in Chapter 4.

3.3.1. Economy and Population

Section 3.3.1 focuses on characteristics of the economy and population in the Cook Inlet area.

3.3.1.1. Socioeconomic Study Area

The nearest governmental jurisdiction that could interact with the proposed leasing activities include the Kenai Peninsula Borough, the Municipality of Anchorage (a city and a Borough under state law), and the Matanuska Susitna Borough, as shown on Figure 3.3.1-1. In Section 3.3, ‘study area’ refers to these regions, and the Kenai Peninsula Borough is the primary focus. In addition, there are several Alaska Native villages and other administrative jurisdictions in the region, more fully described in Sections 3.3.3 and 3.3.4.

Kenai Peninsula Borough is the area most likely to be associated with identifiable socioeconomic effects. Serving as a source of workers, it is likely to benefit from the related effects of income, spending, and taxes. Anchorage and the Matanuska Susitna Borough could be sources of workers and recipients of spending. Baseline information in this section is focused on the Kenai Peninsula Borough, but information on the State of Alaska, Anchorage, and the Matanuska Susitna Borough is presented for context and perspective.

The Kenai Peninsula Borough lies directly south of Anchorage, Alaska's principal population center. The waters of the Gulf of Alaska and Prince William Sound border the borough on the south and east, with the Chigmit Mountains of the Alaska Range rimming the borough to the west. The Cook Inlet divides the borough into two land masses. The peninsula encompasses 99% of the borough's population and most of the development. The largest concentration of the area's population resides in the cities of Kenai and Soldotna, and adjacent areas. Homer is more sparsely populated than the Kenai-Soldotna area, and is focused economically on commercial fishing and tourism (Kenai Peninsula Borough, 2015).

The Kenai Mountains run north and south through the peninsula, contrasting to the lowlands lying to their west. The west side of Cook Inlet is sparsely inhabited, and the village of Tyonek is the largest populated settlement. The borough's boundaries encompass 66,304 km^2 (25,600 mi^2), of which 40,663 km^2 (15,700 mi^2) are land. Total area of the borough equals the combined areas of Massachusetts and New Jersey. However, the total borough population is <1/400th of those states (Kenai Peninsula Borough, 2015).

The Kenai Peninsula Borough has historically been home to many of the Alaskan oil and gas industry's jobs, starting with the discovery of oil and gas deposits in Cook Inlet Basin during the late 1950s and the early 1960s. All of the developed oil and gas fields discovered in the Cook Inlet Basin to date are onshore or in State of Alaska waters (USDOI, BOEM, 2015e).

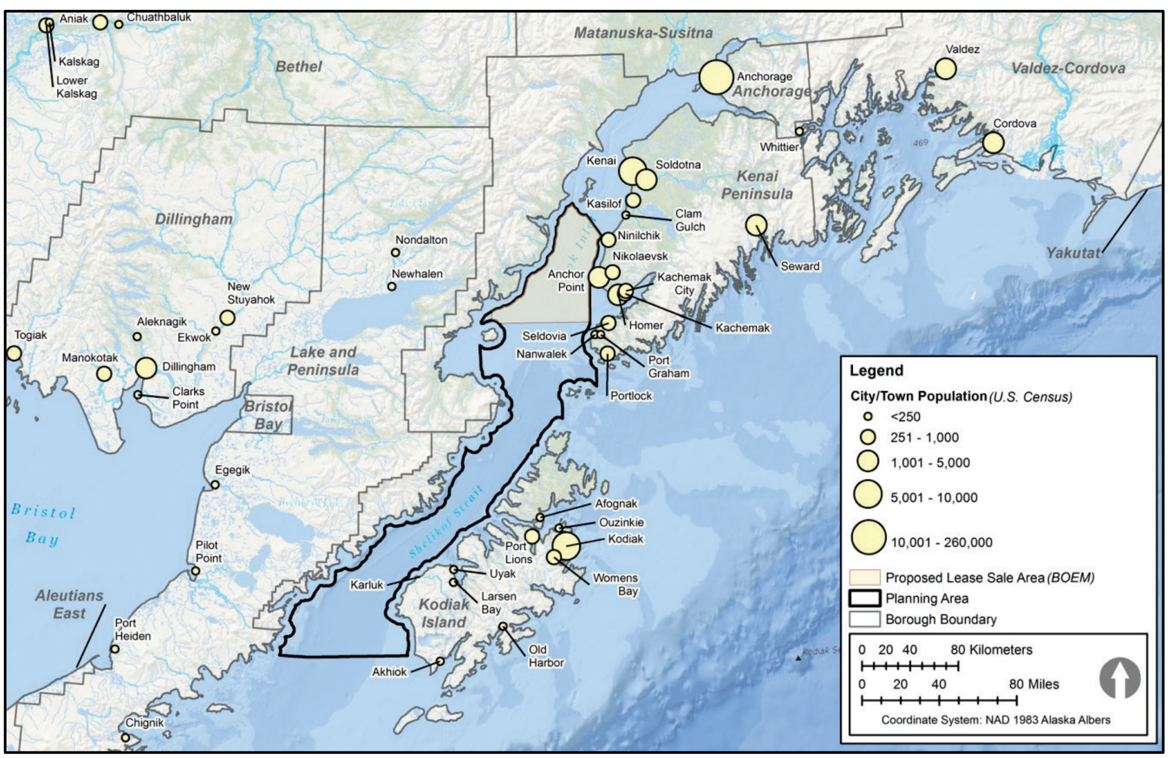


Figure 3.3.1-1. Alaska Boroughs. *Cities and Towns are Proportionally Sized According to Their Respective Populations.*

One of the most important areas in the Kenai Peninsula Borough related to the oil and gas industry is Nikiski, which provides supporting infrastructure and workforce. A substantial portion of the region's crude oil production is transported to the Tesoro Kenai Refinery in Nikiski. The Kenai LNG Plant is located in the Nikiski area. Based on the E&D Scenario developed by BOEM for the Proposed Lease Sale (Section 2.4), Nikiski, Homer, and Anchorage would serve as important support locations for future activity resulting from the Proposed Action.

3.3.1.2. Data Sources and Uses

The Alaska Department of Labor and Workforce Development (ADLWD), the U.S. Census Bureau (USCB), the U.S. Bureau of Labor Statistics, and other state and Federal agencies measure and estimate economic activity, employment, income, and population in the state and in its regions on a regular basis. The data collected, compiled, and reported by these agencies vary somewhat, based on differing data collection, analysis, and estimation techniques. However, data used in this assessment are relatively consistent among agencies, and are adequate to portray existing conditions and recent trends.

In addition to data reported by the identified agencies, information in this section considers analyses and documents from other governmental agencies and private companies. No primary data (e.g., from surveys or interviews) were collected as a part of this assessment.

3.3.1.3. Economic Conditions and Characteristics

Goldsmith (2008) identified three major economic drivers of the statewide and regional economies that each constitute about one-third of direct, indirect, and induced job-creating activity in the state:

- Oil and gas activity
- Federal government activity
- Other basic sectors, including seafood, tourism, mining, timber, international air cargo, and personal assets from outside Alaska

Goldsmith (2008) also identified a variety of special characteristics that shape the Alaskan economy:

- Alaska is a long way from markets and suppliers. Ninety percent of the state has no roads. It has severe winters and significant permafrost.
- The population is small. Only three states have fewer people, and the people and the jobs are concentrated in relatively small areas.
- Alaska has the highest seasonal variation in jobs nationwide. The number of private jobs is about 25% higher in summer.
- Non-residents hold about one-quarter of Alaska's private jobs. Many but not all of these jobs are in industries that ramp-up in summer.
- No other state depends on a single, non-renewable resource as much as Alaska depends on oil production, which is declining.
- Most resource development is in enclaves, in remote locations without an adequate skilled local labor supply, or local support services.
- Resource industries that drive Alaska's economy are dominated by large national or international companies.
- Federal and state governments together own 89% of lands in Alaska, compared with 35% nationwide.
- Nearly one-quarter of Alaska’s jobs are in government, largely because of Federal jobs, compared with a U.S. average of 13%.

Employment and Income

Primary measures of economic conditions and characteristics include employment and income. Oil and gas activity is an important source of statewide employment and income (Section 3.4). Based on employment and wage data, the Alaskan and regional economies of the study area show growing diversification. Table 3.3.1-1 documents average annual employment and the leading employment industries for the major jurisdictions in the study area.

Table 3.3.1-1. Employment, Leading Industries, and Average Weekly Pay in the Study Area for June 2014.

Region	Average Annual Employment, Rounded to Nearest 1000 (Percent of Alaskan Total)	Leading Industries by Employment (% of total)	Average Weekly Pay ($)
Alaska	345,000 (100)	Educational and health services (18); Trade, transportation and utilities (14); Local government (14)	1014
Municipality of Anchorage	155,000 (45)	Trade, transportation and utilities (20); Educational and health services (15); Professional and business services (12)	1056
Matanuska-Susitna Borough	23,000 (7)	Trade, transportation and utilities (19); Educational and health services (19); Local government (15)	790
Kenai Peninsula Borough	23,000 (7)	Trade, transportation and utilities (19); Educational and health services (16); Local government (16)	895

Source: Bureau of Labor Statistics (2015).

As shown by these Bureau of Labor Statistics (2015) data, employment and wages in Anchorage are higher than in other areas near the proposed Lease Sale Area. Top employment sectors in the potentially affected areas include trade, transportation and utilities, educational and health services, local government, and, in Anchorage, professional and business services. The health care sector created several new jobs in recent years as the population has aged. Government employment is important as well throughout the area. Employment has shown gains over the last decade in all jurisdictions.

The relative shares of employment by industry in the Kenai Peninsula Borough are shown in Table 3.3.1-2. These data show the borough's economy is diverse with five industries having at least 10% of the workforce. The borough's economy has been stable in recent years with little total change from 2010 to 2013.

Table 3.3.1-2. Number of Kenai Peninsula Borough Workers Employed by Sector, 2010 and 2013.

Sector	Number of Workers (2010)	Number of Workers (2013)
Natural Resources and Mining	2980	2898
Construction	1459	1467
Manufacturing	904	952
Trade, Transportation and Utilities	4757	4564
Information	292	288
Financial Activities	669	631
Professional and Business Services	1291	1434
Educational and Health Services	3356	3646
Leisure and Hospitality	2503	2522
State Government	1291	1291
Local Government	3320	3439
Other	751	756
Unknown	2	20

Source: ADLWD (2015a).

Unemployment in Alaska has been less variable than in the contiguous U.S. since 2005. Unemployment was 5.3% in Anchorage, and 8.5% in the Matanuska-Susitna Borough and the Kenai Peninsula Borough in April 2015. Unemployment rates in Anchorage are typically lower than in the other jurisdictions, as these data show. Average annual unemployment rate in Kenai Peninsula Borough was 10% in 2010, declining to 7.8% in 2014. Unemployment rates typically vary seasonally within the Kenai Peninsula Borough, ranging from a low of 6.5% in August 2014 to a high of 9.6% in February 2014 (ADLWD, 2015a).

Importance of Oil and Gas Activities in Alaska and its Regional Economies

Employment, income, and spending associated with the oil and gas industry are the state's main economic engine. Alaska oil production peaked in 1988 when the state produced 25% of all U.S. oil. Since that time, oil- and gas-related activities have remained important to statewide and regional economies, despite a decline in oil production. Production levels stabilized in 2015, and industry's activity in the Cook Inlet area have increased over the last four years.

While the ADLWD reports that "direct jobs"[1] associated with oil and gas activity represent just 4% of Alaska's total workforce, the industry generates the lion's share of Alaska's state budget, and also funds many local needs. Average earnings in the industry are more than two-and-a-half times the average for all Alaskan industries. Therefore, the statewide effect of oil and gas is even more pronounced on payroll than on employment (ADLWD, 201315b). This is true for the Kenai Peninsula Borough economy as well. Table 3.3.1-3 shows the percent contribution of Cook Inlet oil and gas activity to recent employment and wages in the Kenai Peninsula Borough.

Table 3.3.1-3. Percent Contribution of Oil and Gas Employment and Wages in the Kenai Peninsula Borough.

	2001 (%)	2005 (%)	2010 (%)	2012 (%)
Contribution of Employment	7.4	5.4	5.6	5.6
Contribution of Wages	15.6	12.9	13.3	11.8

Source: Northern Economics (2014).

Anchorage, the North Slope, and the Kenai Peninsula Borough are home to nearly all of Alaska's oil industry's jobs. The latter two are where all oil is produced and Anchorage, center of a quarter of the industry's jobs, is often the headquarters or service center for many of these employees. Eight percent of the state's oil and gas jobs are in the Kenai Peninsula Borough, as measured by the ADLWD (2013). Though most of the oil industry's jobs are concentrated in these three areas, the industry draws workers from all over the state and nation. Even the state's smaller communities have residents who commute to remote jobs (ADLWD, 2015b). As of 2009, persons living in 13 different Kenai Peninsula Borough communities were employed in Alaska's oil and gas industry. Wages in the existing Cook Inlet oil and gas industry are the highest of those of any industry in the Kenai Peninsula Borough, averaging more than twice the borough average (McDowell Group, 2013). It is important to note that the location of workers' residence is often the primary location of effects from their employment, as 1) workers typically spend their wages in their residential locations, and 2) local

[1] Employment numbers for the oil and gas industry as used by the ADLWD include companies categorized under "oil and gas extraction" (North American Industry Classification System (NAICS) code 211111), "drilling oil and gas wells" (NAICS code 213111), and support activities for oil and gas operations" (NAICS code 213112). This definition does not include oil and gas pipelines, transportation companies, refineries, and many construction companies involved in Alaska's oil and gas operations. It also excludes the tens of thousands of jobs created across a range of other industries — jobs that are often included in studies that quantify the importance of the industry to Alaska's economy (ADLWD, 2015b).

governments need to provide services such as housing, roads, and other infrastructure/public services to these residence locations.

The McDowell Group (2014) conducted a study of the full effect of oil and gas activity on statewide and regional economies. The study identified 16 “primary companies” in Alaska's oil and gas industry, including production and exploration companies, refineries, and pipeline companies. Direct spending by the primary companies on goods, services, and wages for employees in Alaska creates substantial indirect and induced employment and wages for Alaska residents. This effect is often termed the “multiplier effect.” Key state and local area economic impact findings of this study are summarized in Table 3.3.1-4.

Table 3.3.1-4. Alaskan Resident Employment and Wages in the Oil and Gas Industry, 2013.

	Alaska	Kenai Peninsula Borough	Anchorage	Matanuska Susitna Borough
Number Employed				
“Primary companies”	4,700	930	2,300	535
Oil and gas support services	8,400	2,250	2,800	2,200
All other indirect and induced	37,900	2,820	25,900	1,265
Total employment	51,000	6,000	31,000	4,000
Wages (millions of $)				
“Primary companies”	780	135	443	80
Oil and gas support services	700	180	260	170
All other indirect and induced	1,974	115	1,367	60
Total wages	3,454	430	2,070	310

Source: McDowell Group (2014).

Beyond the importance of oil and gas activity to employment and wages as shown in Table 3.3.1-4, Northern Economics (2014) estimated that the Cook Inlet oil and gas industry accounted for about 37% of the Kenai Peninsula Borough total economic output in 2011.

Oil and gas employment opportunities within Alaska and the proposed Lease Sale Area attract potential workers from local and non-local locations. About one-third of the people who work in the oil and gas industry are not residents of Alaska; this percentage has grown in recent years.

As of 2014, the ADLWD projected that oil and gas employment would continue to grow in the future. Robinson (2015), based on ADLWD data, projected the oil and gas industry would have above average growth of approximately 18% (approximately 2,500 jobs) during the 2012 to 2022 period, with 11% growth anticipated for the state as a whole. However, recent decreases in oil and gas prices could certainly affect the accuracy of those projections.

Other Drivers of the Alaska Economy

Beyond the oil and gas industry, there are other industries and sources of economic activity that help to drive the Alaskan economy today. These other primary economic drivers include (Goldsmith, 2008):

- Federal Government – The Federal Government supports more jobs for Alaskans than any private industry, including even the oil and gas industry. Just over a third of Alaskans with jobs depend on Federal spending. Federal spending in Alaska is high relative to the population for several reasons, including a large military presence, huge Federal land holdings, Federal health-care and other programs for Alaska Natives, and continuing construction of basic infrastructure (Goldsmith, 2008).

- Seafood industry – The seafood industry is one of the traditional resource industries important to the state and regional economies. Besides direct fishing and processing jobs, the industry offers opportunities for jobs in boat repair, fuel supply, and air transportation, as well as jobs in other businesses where Alaskan households and businesses spend the income gained from the seafood industry (Goldsmith, 2008).
- Tourism industry – Tourism is a newer basic industry that has become extremely important to the state and regional economies. About half of the tourism jobs are in restaurants, hotels, lodges, sightseeing businesses, and other establishments that provide services to tourists. Additional jobs are generated indirectly when Alaskan households and businesses spend their tourism-related income in the economy (Goldsmith, 2008).
- Mining industry – Mining provides direct jobs in production, exploration, and development, and there are a number of self-employed miners. Mining indirectly supports jobs in businesses that sell supplies to the mines and to construction companies developing mines. Alaska Native corporations own land where several producing or planned mines are located, and royalties they receive from mining companies indirectly support some Native corporation jobs (Goldsmith, 2008).
- Personal assets – Another source of money flowing into the state is personal assets such as retirement checks (referred to as the “mailbox economy”) for older Alaskans, health-care spending for older people through Medicare, Medicaid and private insurance, etc. This economic activity supports both direct and indirect jobs in Alaska.

Subsistence remains an important part of the socio-economic system of rural Alaska (Fall, 2016) and is further discussed in Section 3.3.3. Many small communities have mixed subsistence-cash economies with subsistence often meeting various social and nutritional needs and the cash economy providing supplies, hunting and fishing gear, and family goods. Subsistence is Alaska's original economy, with people in rural areas traditionally getting much of their food directly from lands and waters, including subsistence harvest of salmon. In addition to the economic importance of subsistence, it is a vital part of Alaska Native cultures, identities, and ways of life (Knapp, 2012).

The economic importance of Native corporations also should be noted. The ANCSA of 1971 created both “regional” and “village” Native corporations. The most relevant Native corporation to the socioeconomic study area is the Cook Inlet Region, Inc. (CIRI). CIRI's business operations include real estate, oil and gas services, construction services, environmental remediation, government contracting, tourism and hospitality activities, telecommunications, and resource and energy development. Total CIRI net income in 2014 was >$48 million (CIRI, 2016).

Revenues to Government Jurisdictions

As noted above, oil and gas activity is extremely important to the state and regional economies in Alaska. Unrestricted petroleum revenue provided 75% of FY 2015 Alaskan revenues (ADOR, 2015). The share of unrestricted petroleum revenues to the State of Alaska is projected to range from 65-72% annually until 2025. The unrestricted petroleum revenues come from four components – production tax, royalties, corporate income tax, and petroleum property tax. Petroleum revenues are highly dependent on price, production, lease expenditures, and transportation costs. Overall oil production declined by about 5% in FY2015, with a 5.6% decrease in North Slope production and a 13.6% increase in Cook Inlet production (ADOR, 2015).

Revenue types, recipients of the taxes, and amounts of revenues accruing to government jurisdictions vary based on location of the oil and gas activity, and scope of exploration and production. Oil and gas activity such as leasing, exploration, and production on the OCS generates specific types of revenues to the Federal Government, and state, and local governments in Alaska. The sources of those revenues for activities on past and current OCS leases in Alaska include:

- Federal Government: The major sources of direct Federal revenues from OCS activity in Alaska include bonus bids (cash payments paid to the Federal Government for the right to explore and develop resources in OCS areas), lease revenues (annual payments established in the lease agreement until production begins), royalties (a percentage of production value, based on a royalty rate and the amount produced), and corporate income taxes. There also may be indirect revenues paid to the Federal Government associated with indirect and induced economic activity.
- State of Alaska Government: The major sources of direct revenues accruing to the State of Alaska from OCS activity includes property taxes (based on assessed valuations and mill levy rates), and corporate income taxes. There also are indirect revenues paid to Alaska associated with indirect and induced economic activity. Actual taxes from oil and gas activity in Cook Inlet may be affected by the Cook Inlet Recovery Act, which provides tax credits for various oil and gas activities in the area.
- Local governments (such as that of the Kenai Peninsula Borough): The major source of direct revenue from OCS activity to local governments includes property taxes (based on assessed valuations and mill levy rates) associated with oil and gas property within the jurisdiction of a government district. There also are indirect revenues paid to local governments associated with indirect and induced economic activity.

The Kenai Peninsula Borough relies on property and sales taxes for most of its revenues. Oil and gas activity is important in terms of property taxes for specific oil and gas property, and total economic activity that helps generate other real and personal property taxes and sales taxes. Table 3.3.1-5 summarizes recent tax revenue information for the borough for these categories.

Table 3.3.1-5. Recent Major Tax Revenues and Sources for the Kenai Peninsula Borough.

	2000 (million $)	2010 (million $)	2014 (million $)
Oil and Gas Property Tax	5.6	6.8	9.3
Real and Personal Property Tax, Excluding Oil and Gas	31.9	47.7	49.4
Sales Tax	12.7	26	30.3

Source: Alaska Department of Commerce (2015).

3.3.1.4. Population

Population growth and trends are key indicators of the level and condition of economic activity within a region. People residing in an area can serve as sources of employment, and can be the recipients of the various benefits and costs associated with a new project such as the Proposed Action.

Alaska is a remote area, but natural resources such as furs, gold, fish, timber, and oil and gas have served as a magnet for population growth over the past century, especially since the end of World War II. More recently, service industries, such as health care and tourism, have drawn additional people into the state and the socioeconomic study area. Desires for a remote, scenic, and adventurous lifestyle also have attracted new population to Alaska and the socioeconomic study area.

Population Estimates

By the time Alaska reached statehood in 1959, the population was roughly 224,000. Since then, the state has grown at varying rates, depending primarily on changing economic conditions and opportunities. Boom and bust cycles have been the norm in Alaska for many years, although the economy has become more stable in recent years as it matured and diversified. The 1968 discovery of oil in Prudhoe Bay, and the subsequent construction of the Trans-Alaska Oil Pipeline in the 1970s spurred significant population growth, both immediately and in the following decades (ADLWD, 2015b). Alaska's population can be transient, with people migrating in and out depending on employment opportunities and desired lifestyles. This is especially true for people with jobs in the oil- and gas-related sector.

Statewide, some of the population data compiled by the ADLWD (2015b) include:

- Population estimate – The July 1, 2013 population of Alaska was 736,399 (52% male and 48% female), and represented 0.2% of the U.S. population. Between July 2012 and July 2013, Alaska's total population increased by 4,572 people (0.6%).
- Age – Alaska's median age was 34.3 in 2013, somewhat less than the national median of 37.6. About 9% of that population was age 65 or older, while children aged 5 to 17 represented 18%. Areas with larger percentages of Alaska Natives generally had lower median ages.
- Race and ethnicity – As of July 1, 2013, Alaska's population was 15% Alaska Native or American Indian, 67% White, 6% Asian, 4% African American, 1% Native Hawaiian or other Pacific Islander, and 7% multi-racial.
- Migration – Between 2012 and 2013, Alaska's high migration rates continued from previous years, with 49,841 people migrating into the state and 52,689 migrating out, for a net migration loss of 2,848 people. Net migration loss was countered by combined births and deaths to yield a slow total population growth.
- Population centers – 80% of Alaska's population lived in cities or places with populations of ≥2,500 in 2013. The five boroughs with the largest populations in the state contained 80% of the population. Ranked in order of highest to lowest population, those five boroughs are: the Municipality of Anchorage, Matanuska Susitna Borough, Fairbanks North Star Borough, Kenai Peninsula Borough, and the City and Borough of Juneau.
- Households – Alaska had >262,000 households in 2013, and the average family size was 2.7.
- Density – Alaska had 1.3 people per 2.6 km^2 (1 mi^2) in 2013, in contrast to 89.5 people per 2.6 km^2 (1 mi^2) for the U.S. as a whole. Anchorage contains 41% of the state's population but only 0.3% of the land; excluding the Anchorage population, the rest of Alaska had an average of 0.8 people per 2.6 km^2 (1 mi^2) in 2013.

The Alaska Native population more than doubled between 1970 and 2010 (from approximately 50,000 to almost 105,000 people). One of the major factors allowing this growth is improved healthcare, which helped Alaska Native adults live longer, and reduced infant mortality. Alaska Natives remain the majority population in remote rural areas, although there has been an influx to urban areas given economic and educational opportunities, and the high cost of living in some rural areas.

Population estimates are shown in Table 3.3.1-6. The Matanuska-Susitna Borough had the highest growth rate over the 2000-2013 period, almost 5% per year. The Kenai Peninsula Borough and Municipality of Anchorage experienced less growth, averaging slightly >1% per year over that period. Selected demographic data for the Kenai Peninsula Borough in comparison to the statewide population are shown in Table 3.3.1-7.

Table 3.3.1-6. Recent Population Estimates for Socioeconomic Study Area, 2000–2013.

Geographic Area	2000	2010	2013
Alaska	626,932	710,231	736,399
Anchorage	260,283	291,826	301,134
Matanuska Susitna Borough	59,322	88,995	96,074
Kenai Peninsula Borough	49,691	55,400	56,862

Source: ADLWD (2015b).

Table 3.3.1-7. Select Demographic Data for the Alaskan and Kenai Peninsula Borough Populations.

Demographics	Kenai Peninsula Borough	Alaska
Racial Composition		
White alone, percent, 2013	84.6	67.30
Black or African American alone, percent, 2013	0.9	3.9
American Indian and Alaska Native alone, percent, 2013	7.4	14.7
Asian alone, percent, 2013	1.3	5.8
Native Hawaiian and Other Pacific Islander alone, percent, 2013	0.3	1.2
Two or More Races, percent, 2013	5.5	7.1
Hispanic or Latino, percent, 2013	3.8	6.6
White alone, not Hispanic or Latino, percent, 2013	81.6	62.5
Living in same house 1 year and over, percent, 2009-2013	83.7	80.3
Foreign born persons, percent, 2009-2013	2.6	7.0
Language other than English spoken at home, percent age 5+, 2009-2013	8.2	16.2
High school graduate or higher, percent of persons age 25+, 2009-2013	92.8	91.6
Bachelor's degree or higher, percent of persons age 25+, 2009-2013	23.7	27.5
Veterans, 2009-2013	6,137	71,004
Mean travel time to work (minutes), workers age 16+, 2009-2013	19.1	18.8
Housing units, 2013	30,580	307,399
Homeownership rate, percent, 2009-2013	72.7	63.8
Housing units in multi-unit structures, percent, 2009-2013	11.7	24.0
Median value of owner-occupied housing units, 2009-2013	$204,900	$241,800
Number of Households, 2009-2013	21,720	251,899
People per household, 2009-2013	2.50	2.75
Per capita monetary income in past 12 months (2013 dollars), 2009-2013	$31,256	$32,651
Median household income, 2009-2013	$61,793	$70,760
Persons below poverty level, percent, 2009-2013	8.6	9.9

Source: USCB (2015).

Population Projections

In addition to making population estimates, the ADLWD also prepares population projections. Alaska's population is projected to increase to approximately 925,000 people in 2042. As the population ages in the coming years, annual natural growth (that based on births and deaths) is expected to slow. Alaska's population aged ≥65 is expected to grow at the fastest rate over the projection period, followed by the ≤17 age range. The population aged 18 to 64 is projected to grow at the slowest rate. Over this period, the growth rates in Anchorage and the Kenai Peninsula Borough are projected at <1% per year, while growth in the Matanuska Susitna Borough is projected at a higher rate of approximately 2.5% per year (ADLWD, 2014).

3.3.2. Commercial Fishing

The central Gulf of Alaska supports a large and diverse commercial fishery for shellfish, salmon, herring, and groundfish. Commercial fisheries in these waters include salmon; herring; groundfish (halibut, lingcod, rockfish, sablefish, pollock, and Pacific cod); and shellfish (crab, shrimp, scallops, and clams). All five species of Pacific salmon, Pacific herring, and smelt are commercially harvested in the Cook Inlet area. Numerous groundfish species are commercially harvested in directed fisheries including Pacific cod, sablefish, lingcod, and pelagic shelf rockfish (primarily black rockfish). Other groundfish species commercially harvested as bycatch to other directed groundfish and halibut fisheries include walleye pollock, skate, and a variety of rockfish species. Shellfish species commercially harvested in the Cook Inlet Area are octopus, which may be retained as bycatch to other directed fisheries, weathervane scallops, and razor clams. Many of Cook Inlet's other commercial fisheries, including crab, littleneck clam (*Protothaca stamineais*), and shrimp fisheries have been closed or greatly reduced in the last 20 years due to low stock levels (ADFG, 2015a). The commercial fishing seasons for salmon, herring, shellfish, and groundfish for Cook Inlet, Prince William Sound/Copper River, Alaska Peninsula, Chignik, and Kodiak are shown in Tables 3.3.2-1 through 3.3.2-4.

Table 3.3.2-1. Commercial Fishing Season for Cook Inlet.

Salmon	Jan	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec
Upper Cook Inlet												
Chinook						Gillnet						
Coho							Gillnet					
Pink							Gillnet					
Sockeye						Gillnet						
Chum							Gillnet					
Lower Cook Inlet												
Pink							Gillnet/Seine					
Sockeye						Gillnet/Seine						
Chum						Gillnet/Seine						
Herring	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**August**	**Sept**	**Oct**	**Nov**	**Dec**
Sac roe and food/bait				Gillnet								
Shellfish	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**August**	**Sept**	**Oct**	**Nov**	**Dec**
Razor Clam						Shovel						
Hard-shell Clam							Rake					
Scallop								Dredge				
Groundfish	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**August**	**Sept**	**Oct**	**Nov**	**Dec**
Pacific Cod	Parallel				State Waters (Pots/Jig)				Parallel			
Rockfish	Bycatch Only (mandatory full retention all year)								Jig (directed)			
Sablefish							Longline/Pot (closes by EO)					
Lingcod							Jig (directed)/Longline (bycatch only)					

Table 3.3.2-2. Commercial Fishing Season for the Alaska Peninsula.

Salmon	Jan	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec
Chinook						Gillnet						
Coho								Gillnet/Seine				
Pink							Gillnet/Seine					
Sockeye						Gillnet/Seine						
Chum							Gillnet/Seine					
Herring	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**August**	**Sept**	**Oct**	**Nov**	**Dec**
North/South Peninsula												
Sac roe									Pot			
Shellfish	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**August**	**Sept**	**Oct**	**Nov**	**Dec**
Dungeness Crab								Shovel				
Tanner Crab		Pot										
Shrimp				Pot/Trawl (Jan 1 to March 15 and May 15 to Dec 31)								
Scallop	Dredge								Dredge			

<table>
<tr><th>Groundfish</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Cod</td><td colspan="12">Pots/Jig</td></tr>
<tr><td>Rockfish</td><td colspan="12">Pot</td></tr>
</table>

Table 3.3.2-3. Commercial Fishing Season for Chignik.

<table>
<tr><th>Salmon</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Coho</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Purse Seine</td><td></td><td></td><td></td></tr>
<tr><td>Pink</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Purse Seine</td><td></td><td></td><td></td></tr>
<tr><td>Sockeye</td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Purse Seine</td><td></td><td></td><td></td></tr>
<tr><td>Chum</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Purse Seine</td><td></td><td></td><td></td></tr>
<tr><th>Groundfish</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Cod</td><td colspan="12">Pot/Jig</td></tr>
<tr><td>Rockfish</td><td colspan="12">Jig</td></tr>
</table>

Table 3.3.2-4. Commercial Fishing Season for Kodiak.

<table>
<tr><th>Salmon</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Coho</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Seine/Gillnet</td><td></td><td></td><td></td></tr>
<tr><td>Pink</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Seine/Gillnet</td><td></td><td></td></tr>
<tr><td>Sockeye</td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Seine/Gillnet</td><td></td><td></td><td></td></tr>
<tr><td>Chum</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Seine/Gillnet</td><td></td><td></td><td></td><td></td></tr>
<tr><th>Herring</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Food/bait</td><td colspan="2">Trawl/Seine/ Gillnet</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Trawl/Seine/Gillnet</td></tr>
<tr><td>Sac roe</td><td></td><td></td><td></td><td colspan="3">Seine/Gillnet</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th>Shellfish</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Dungeness Crab</td><td></td><td></td><td></td><td></td><td colspan="8">Pot</td></tr>
<tr><td>Tanner Crab</td><td colspan="3">Rake</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Shrimp</td><td colspan="2">Trawl</td><td></td><td></td><td></td><td></td><td colspan="6">Trawl</td></tr>
<tr><td>Shrimp</td><td colspan="12">Pot</td></tr>
<tr><td>Scallop</td><td colspan="2">Dredge</td><td></td><td></td><td></td><td></td><td colspan="6">Dredge</td></tr>
<tr><td>Sea Urchin</td><td>Dive</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Dive</td></tr>
<tr><td>Sea Cucumber</td><td colspan="4">Dive</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Dive</td></tr>
<tr><th>Groundfish</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Cod</td><td colspan="12">Pot/Jig</td></tr>
<tr><td>Rockfish</td><td colspan="12">Jig</td></tr>
</table>

3.3.2.1. Shellfish Fishery

The Cook Inlet Management Area, as it applies to commercial and personal use fisheries, is divided into six shellfish districts: Central, Southern, Kamishak, Barren Islands, Outer, and Eastern. Cook Inlet and the waters adjacent to Kodiak and Chignik have supported commercial shellfish fisheries for red king, Tanner, and Dungeness crabs; the weathervane scallop, hard-shell clams, shrimp, and sea urchin; commercial fishing also has targeted razor clams in Cook Inlet, and sea cucumber in waters adjacent to Kodiak and Chignik. Due to low levels of abundance in the Cook Inlet area, fisheries for red king, Tanner, Dungeness crabs and shrimp have been closed for some time. Sport and personal use fishing seasons for Cook Inlet shrimp fisheries were closed by regulation beginning in 1997 due to low abundance (Trowbridge and Goldman, 2006). Similar regulations closed commercial fisheries for green urchin, sea cucumber, Dungeness crab, and the directed fishery for octopus. Only fisheries for the weathervane scallop and hard-shell and razor clams remain open in the Cook Inlet area.

Crabs

Crabs are commercially caught using baited pots that usually are deployed in strings (lines) in large numbers. These pots have rebar metal frames with netting over them and with one or more biodegradable net panels to allow the catch to escape in the event the pot is lost. Pots may become lost when their buoy lines or other lines part, or the buoys are sunk. This can be caused by a number of factors including storms, other vessel traffic, and marine mammal predation. The use of crab rings also is allowed to commercially harvest Dungeness crab, and in some Tanner crab fisheries. Pot soak time has declined over the years from several days to only 12 hours, as the length of the fishing season has been reduced. Female and undersized males are returned to the sea, and legal males are retained in live tanks or are processed immediately in the absence of live tanks.

In the Cook Inlet region, red king crabs have been commercially fished since the late 1930s. Most of the fishing occurred in the Southern or the Kamishak/Barren Islands Shellfish Districts. However, catches were terminated in the early 1980s when the red king crab stocks crashed in Cook Inlet. Catches in the Tanner crab fishery in Cook Inlet have been recorded since 1968, but the fishery was closed in 1995 due to low abundance levels, and has remained closed. All non-commercial Tanner crab fisheries (those for subsistence, personal use, and sport) in Cook Inlet will remain closed for the 2015 to 201616 season. Surveys were last conducted in 2013 for Kachemak Bay and 2012 for Kamishak Bay, and survey results for legal male Tanner crab were well below that needed to open the fishery according to the 5 AAC 35.408 Registration Area H Tanner Crab Harvest Strategy.

Catches for the Dungeness crab fishery in Cook Inlet have been recorded since 1961. All commercial Dungeness fishing was closed in the Cook Inlet area in 1997 due to low crab abundance throughout the area. These fisheries are closed until stocks recover, and a management plan is adopted that considers 14 criteria specified in the regulation (5 AAC 32.390) (Trowbridge and Goldman, 2006).

The ADFG manages crab fisheries of the Cook Inlet, Kodiak, and Alaska Peninsula areas in cooperation with NMFS and the NPFMC. The State of Alaska is able to regulate crab fisheries in Federal waters by providing that crab harvests landed in Alaskan ports must be taken in compliance with state management regulations. To ensure conservation of crab resources, seasons are established by ADFG, and, for some species, harvest quotas (or limits) are set with coordination and in cooperation with the Federal fisheries agencies.

Shrimp

The Cook Inlet and Kodiak commercial shrimp fisheries have included northern, sidestriped, coonstriped, spot, and humpy shrimp fisheries. Spot and coonstriped shrimp were harvested by pot gear at depths $\geq$9 m (29 ft) or deeper in Cook Inlet. Northern, sidestriped, and humpy shrimp are harvested by bottom-trawl gear.

In the Cook Inlet area, shrimp have been commercially fished since 1915, but catches were not recorded until the 1950s. Most of the fishing occurred in the Southern Shellfish District. Catches peaked during the 1980 to 1981 season at 2,802 metric tons (3,088 tons), but trawl surveys indicated that shrimp abundances in the area had been declining since the 1970s. The shrimp fishery in lower Cook Inlet was closed in the 1987 to 1988 season, and has remained closed most of the time since then (Trowbridge and Goldman, 2006). Shrimp fisheries outside of Cook Inlet along the outer Kenai Peninsula are small by comparison but also were closed in the 1997 to 1998 season for the same reason.

Scallops

Weathervane scallops are harvested by vessels towing dredges mostly in waters 70 to 110 m (229 to 360 ft) deep. Scallops are harvested commercially during some years, but these efforts have been limited until recently. The commercial fishery for weathervane scallops began in the Cook Inlet area in 1983. Catches have been sporadic and centered on a single scallop bed near Augustine Island in the Kamishak District of lower Cook Inlet, which has produced all of the catches since 1983. A recent steep decline in biomass of Kamishak District scallops has been reflected in both the ADFG's survey, and analysis of fishery catch per unit effort. Take from the north bed declined by approximately 67% between the 2001 and 2003 surveys, and appeared to stabilize based upon the 2005 survey. Similarly, take from the south bed declined by approximately 75% between the 2003 and 2005 surveys. The 2005 scallop season had a quota of 3,175 kg (7,000 pound (lb)) Guideline Harvest Level, equivalent to a 4% harvest rate (Trowbridge and Goldman, 2006).

Commercially Harvested Invertebrates

Other shellfish commercially fished in the Cook Inlet area include Pacific hard-shell and razor clams, sea cucumbers, and sea urchins. Most of the hard-shell clams harvested are Pacific little neck (mostly from Kachemak Bay, and butter clams (*Saxidomas gigantea*). The 2011 upper Cook Inlet razor clam harvest, taken primarily from the Polly Creek/Crescent River area, was approximately 85,729 kg (189,000 lb) in the shell (Shields and Dupuis, 2012). The 2014 harvest, taken primarily from the Polly Creek/Crescent River area, was approximately 157,850 kg (348,000 lb) in the shell (Shields and Dupuis, 2015). Approximately 19 diggers participated in the fishery and they were paid an average of $0.65 per pound for their harvest, resulting in an ex-vessel value for this fishery of approximately $226,000.

3.3.2.2. Herring Fishery

Pacific herring are harvested annually in Cook Inlet in addition to the waters adjacent to Kodiak, Chignik, and the South Alaskan Peninsula. Pacific herring in the Gulf of Alaska are much smaller than those of the Bering Sea, and they do not live as long or migrate nearly as far. Herring are used mainly for their roe and sac-roe-on kelp, which is marketed in Pacific Rim countries, and to a much lesser extent for food or bait, which is marketed in Alaska. Some carcasses are processed into fishmeal after the sac roe is removed. The fish itself is purchased by the ton, while sac-roe-on-kelp is purchased by the pound.

The ADFG divides Cook Inlet into upper and lower management districts, each with a different management team, and each with their own subdistricts (Figure 3.3.2-1). In the upper Cook Inlet area, commercial herring fishing began in 1973. Annual harvests have averaged well under 363 metric tons (400 tons), or <$200,000 ex-vessel value, which makes it one of the smallest herring fisheries in the state. Gill nets currently are the only legal gear for herring in upper Cook Inlet, and set nets are used almost exclusively. There are three primary fisheries in the upper Cook Inlet area: the eastside, Chinitna Bay, and Tuxedni Bay fisheries. Due to low stock abundance, all of these were closed to fishing by 1993. In 1998 the eastside fishery was reopened from April 15 to May 20, but for only two days a week. The 2011 upper Cook Inlet herring fishery produced a harvest of 14.7 metric tons (16 tons), with all but 2.3 metric tons (3 tons) of the harvest coming from the Upper Cook Inlet Subdistrict. Fifteen permit holders reported fishing, which was analogous to the average annual number of participants in the previous 10 years (2001 to 2010) (Shields and Dupuis, 2012). The 2014 upper Cook Inlet herring fishery produced a harvest of 26.3 metric tons (29 tons), with all of the harvest coming from the Upper Cook Inlet Subdistrict (Shields and Dupuis, 2015). This was the second largest herring harvest in upper Cook Inlet since the fishery reopened in 1998. All of the herring harvested in upper Cook Inlet were used exclusively for personal use or sold as bait. Because Prince William Sound and Kamishak Bay herring fisheries have remained closed for many years, bait herring from upper Cook Inlet has risen in value. Demand by commercial and sport halibut fishers has resulted in an average price of at least $1.00/lb or $2,000/ton. Based on this price, the estimated ex-vessel value of the 2014 commercial herring fishery was approximately $58,000 (Shields and Dupuis, 2015).

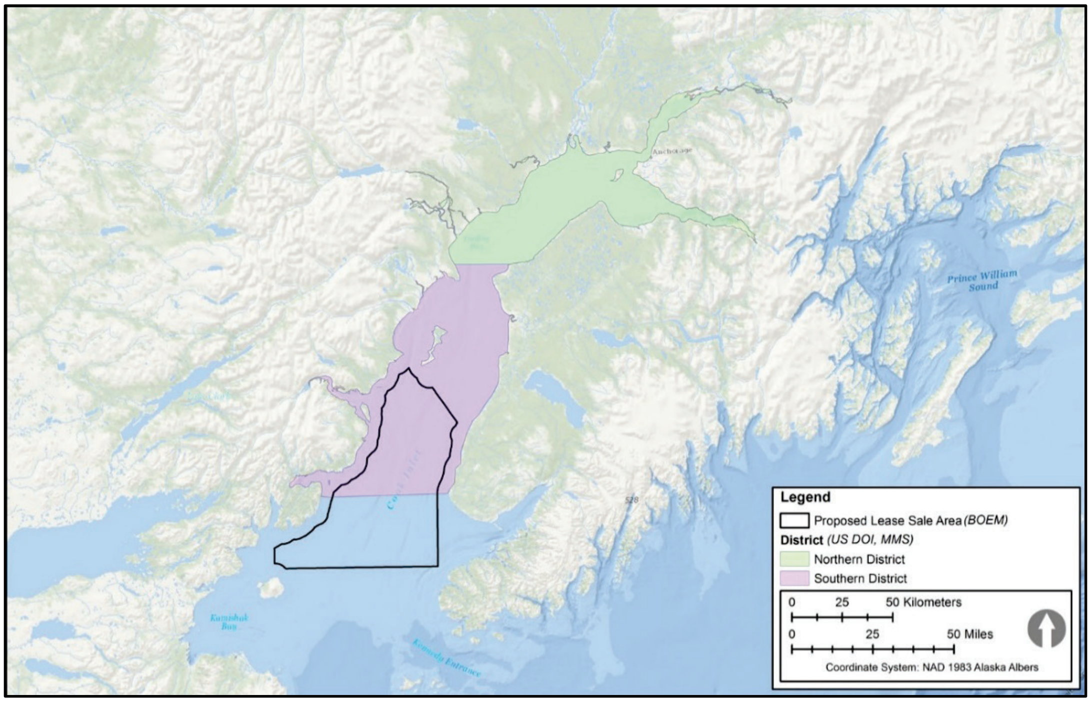


Figure 3.3.2-1 Upper Cook Inlet Commercial Fisheries Subdistrict Fishing Boundaries.

In the lower Cook Inlet, commercial herring fishing began in 1914 with the development of a gillnet fishery in Kachemak Bay. A purse seine fishery developed there in 1923 but by 1926, the herring population and the fishery had collapsed. The next lower Cook Inlet herring fishery began in 1939 in the eastern district, which is farthest from lower Cook Inlet and is centered in Resurrection Bay. It ended in 1959 when stocks declined, apparently due to overexploitation. Due to Japanese market demand, a sac roe herring fishery developed in lower Cook Inlet in the 1960s. However, from 1961 to 2001, the southern, eastern, and outer districts either were not fished or were closed much of the time due to low stock abundance. Since 1973, most of the lower Cook Inlet sac roe harvests have occurred in the Kamishak Bay district where abundances were higher. Harvests have ranged from 220 metric tons (243 tons) in 1973, to a high of 5,562 metric tons (6,132 tons) in 1987. From 1973 to 1998, ex-vessel values in the Kamishak Bay district have ranged from \$70,000 to \$9,300,000. Due to low stock abundance, the Kamishak Bay fishery was closed in 1980, but was opened again in 1985, when stocks improved. However, the Kamishak Bay fishery was closed again in 1999 for the same reason and has remained closed. No commercial fisheries for herring occurred in lower Cook Inlet during 2013 in order to allow the population further opportunity to rebuild from historically low abundance (Hollowell, Otis, and Ford, 2014).

Management: The management of herring stocks in Cook Inlet and the Kodiak areas is carried out by ADFG and the Alaska Board of Fisheries, an appointed body. The ADFG has management jurisdiction for herring fisheries extending from shore to 4.8 km (3 mi) offshore (commonly referred to as “state waters”). The NPFMC has management jurisdiction extending from 4.8 to 322 km (3 to 200 mi) offshore, through the EEZ. ADFG has the authority to impose emergency closures and other management actions to conserve all Alaskan herring populations within the 4.8-km (3-mi) limit. For sac roe fisheries, ADFG sets herring openings to occur when herring have produced the maximum amount of roe. Seasons and management regulations are reviewed periodically and published annually by ADFG. Entry into most herring fisheries in Alaska is limited under the authority of the Commercial Fisheries Entry Commission. Federal regulations preclude retention of herring bycatch harvested in trawl fisheries.

3.3.2.3. Salmon Fishery

In Cook Inlet and the waters adjacent to Kodiak, Chignik, and the southern Alaska Peninsula, all five species of Pacific salmon are harvested commercially, as well as for subsistence and sport. Second only to Alaska's groundfish fishery, Alaska's salmon fishery is one of the largest fisheries in volume and value. The estimated total ex-vessel value of salmon fisheries in 2014 was approximately $37 million in Cook Inlet (ADFG, 2014). Salmon fisheries in Shelikof Strait and near Kodiak Island are closely equivalent in both volume and value to those in Cook Inlet, with slightly different fishing seasons and periods. Cook Inlet and Kodiak salmon fisheries use purse seines, drift gillnets, set gillnets and, in small numbers, beach seines. Regional salmon fisheries commence in early May and continue well into September each year. Drift-gillnet vessels in the Cook Inlet area fish for herring in mid-April through May 20 and for salmon into August.

Purse seines are long nets played into the water from the vessel as it travels in a large circle. A dory is positioned at the end of the net and, when the circle is nearly complete, the end is brought up to the vessel. The net balloons out to encircle a school of salmon, after which the net is pulled closed (pursed) at the bottom, trapping the fish. The seine and its catch are then hoisted aboard the vessel. Purse seines are most efficient in catching pink, chum, and sockeye salmon, species that congregate in large schools. Drift gillnets are deployed from the fishing vessel and fish at a depth well off the bottom, held in position by lead lines and floats. They may drift with the tide or be maneuvered by the fishing vessel. The salmon are enmeshed by their gills as they attempt to pass through the net. After a period of time, the net is reeled aboard and the salmon removed. Set nets also enmesh migrating salmon. They are fixed gillnets that usually are fished nearshore. The net may then be beached or a small skiff used to remove the catch. Beach seines have limited use in the Cook Inlet and Shelikof Strait region. These nets are deployed from shore, and a boat is used to attempt to encircle salmon, after which the seine is beached.

The 2014 upper Cook Inlet commercial harvest of 3.2 million salmon was approximately 21% less than the 1966 to 2013 average annual harvest of 4.1 million fish (Shields and Dupuis, 2015). The 2014 sockeye salmon harvest estimate of 2.3 million fish was 20% less than the 1966 to 2013 average annual harvest of 2.9 million fish. The estimated ex-vessel value of the 2014 upper Cook Inlet commercial salmon fishery of $35.1 million was approximately 24% more than the average annual ex-vessel value of $28.4 million from the previous 10 years (2004 to 2013), and approximately 34% more than the 1966 to 2013 average annual ex-vessel value of $26.1 million (Shields and Dupuis, 2015).

The 2014 lower Cook Inlet management area commercial salmon harvest was 616,554 fish. The harvest was composed of 271,200 pink, 270,835 sockeye, 73,498 chum, 663 coho, and 358 Chinook salmon (Hollowell, Otis, and Ford, 2015). Hatchery runs of sockeye salmon in general were above forecast in Resurrection Bay and below forecast at other hatchery release sites. Harvest of coho, pink, and chum salmon were below the 10-year (2004 to 2013) average. Approximately 72% of the harvest, 443,064 fish, was attributed to the common property fishery and 173,490 fish to hatchery cost recovery. An additional 11,959 sockeye and 31,767 pink salmon were harvested by hatcheries for broodstock. The 2014 preliminary ex-vessel value estimates by gear group from the common property fishery, both harvested wild salmon and hatchery stocked salmon, were $1.2 million (71.5%) for the purse seine fishery and $469,291 (28.5%) for the set gillnet fishery. The average price per pound paid to fishers was above the 10-year average for all species. The total harvest values for the purse seine fishery in 2014 was approximately 25% lower than the 10-year harvest average, whereas the set gillnet fishery's harvest value was nearly double its 10-year average (Hollowell, Otis, and Ford, 2015).

Management: The ADFG and the appointed Alaska Board of Fisheries manage the salmon stocks in the Cook Inlet, Kodiak, and the Alaskan Peninsula areas. The seasons are set and the salmon fisheries are managed intensively for conservation. Within a fishing season, there are closed periods to allow for adequate spawning escapements, usually over weekends. Additionally, when spawning escapement numbers are low, ADFG has the authority to impose emergency closures and other management actions to increase the number of salmon reaching the spawning grounds. Seasons and management regulations are reviewed periodically and published annually by ADFG.

3.3.2.4. Groundfish Fishery

Groundfish are commercially harvested in all four ADFG commercial fishing regions. This includes the Cook Inlet area of the Central Management Region, and the Kodiak, Chignik, and the South Alaskan Peninsula waters of the Westward Region. The groundfish fishery is the largest commercial fishery in Alaska by volume and value. Most Alaskan groundfish are landed in the Bering Sea/Aleutian Islands area of the Central Management Region outside the proposed Lease Sale Area. Commercially harvested groundfish of the Central and Westward Management Regions have included, but are not limited to, rockfish (numerous species), flatfish (including halibut), Pacific cod, lingcod, sablefish, and pollock. Some species landed as bycatch include spiny dogfish, Pacific sleeper shark, Pacific salmon shark, majestic squid (*Berryteuthis magister*), giant Pacific octopus (*Enteroctopus dofleini*), and various species of skates. ADFG's Division of Commercial Fisheries manages all commercial groundfish fisheries within the territorial waters of the Cook Inlet Management Area. Under state regulation 5 AAC 39.975 Definitions (21), groundfish are defined as all marine finfish except halibut, osmerids, herring, and salmonids. Although ADFG manages halibut separately from groundfish, halibut is a groundfish and has been included here to avoid confusion.

Groundfish are harvested with trawls, pots, longlines, and small sunken gillnets. Trawls used to catch groundfish are similar in construction to those used in the shrimp fishery; however, they are much larger and are fished differently. Bottom trawls employ heavy panels (doors) and chains to maintain depth and position during trawling. The usual vessel for these trawl fisheries is the stern trawler, where the trawl net is deployed from the stern of the vessel and tows may cover many miles while conducted over extended periods of time. Larger trawl vessels have onboard processing capabilities and may fish for two to three months before returning to port. The lower Cook Inlet and Kodiak/Shelikof Strait longline fishery primarily harvests sablefish (black cod), Pacific cod, and halibut. Longlines have several leaders (ganglions) with baited hooks and are strung over long distances along the seafloor. Lines are anchored and buoyed and allowed to fish for several hours before retrieval. An increasing number of fishers now use small pots to harvest sablefish and cod; some use sunken gillnets to harvest some species of groundfish. Groundfish landings and ex-vessel earnings in the Cook Inlet area for sablefish, rockfish, lingcod, Pacific cod, pollock, and other species have varied substantially over time.

The groundfish fishery is the largest commercial fishery in Alaska in volume and value. During 2011, the groundfish harvest totaled nearly 2,449,399 kg (5.4 million lb) in Cook Inlet, the largest since 1999, and generated an estimated ex-vessel value of $2.35 million, the highest value to date (Russ, Trowbridge, and Russ, 2013). Pacific cod fishing has had the greatest economic yield of Cook Inlet commercial groundfish harvests since 1990. The 2011 Pacific cod value was just over $2 million, the highest to date and nearly twice the 2010 value. Sablefish has generated the second highest annual ex-vessel value since 2000, based primarily on a high dockside price that has more than doubled in the same time period ($4.55/lb, round weight, in 2011). Rockfish harvest increased in 2011, although there has been a decline since 2000. Lingcod harvest declined in 2011 to less than half the 2010 harvest and is at its lowest level since 1990. Walleye pollock harvest has remained low (Russ, Trowbridge, and Russ, 2013).

Halibut is the major commercial groundfish fishery in the Cook Inlet area (Homer, Kenai, Ninilchik, Seldovia, and Seward) with landings totaling 6,961,242 kg (15,346,912 lb) in 2000, and 8,975,645 kg (19,787,911 lb) in 2001 (International Pacific Halibut Commission (IPHC), 2015). The IPHC estimated total removals for regulatory area 3A at 7,711,524 kg (17,001,000 lb) during the 2013 season (IPHC, 2015).

Management: The ADFG and NMFS share and coordinate management responsibilities for Alaska's groundfish fisheries. The ADFG has management jurisdiction for groundfish stocks extending from shore to 4.8 km (3 mi) offshore. The ADFG also has management jurisdiction for lingcod, dark rockfish and black rockfish fisheries to 322 km (200 mi) offshore. The ADFG manages all commercial groundfish fisheries within Cook Inlet. However, most of the groundfish fisheries off the Alaskan coast (those covered by the FMPs) fall under NMFS management jurisdiction, which begins 4.8 km (3 mi) offshore and ends 322 km (200 mi) offshore at the boundary of the EEZ. FMPs are developed by the NPFMC to manage the EEZ. NMFS, the NPFMC, and the IPHC establish seasons for each groundfish species, and harvest quotas called the total allowable catch. Because the commercial-fishing effort cannot completely discriminate, some non-target species also are caught, for example, halibut taken in the pollock-trawl fishery. This bycatch must be released, and in some fisheries, bycatch becomes a limiting factor for that fishery, as a season is closed when a bycatch limit is reached.

3.3.2.5. Fish Hatcheries and Aquatic Farms

The ADFG oversees and regulates all state and private sector salmon rehabilitation and enhancement projects. The salmon-enhancement program is composed of several groups: two state hatcheries; 29 private, nonprofit corporation hatcheries; two Federal hatcheries; and several streamside incubation and restoration projects.

In 2014, hatchery operators collected an estimated 2.0 billion eggs and released 1.8 billion juvenile fish (Vercessi, 2014). Approximately 62.1 million hatchery-produced salmon returned, with the majority (42 million) being pink salmon produced by hatcheries in Prince William Sound (PWS) (Vercessi, 2014). The preliminary total statewide commercial salmon harvest was 157 million fish, with 149 million salmon harvested in the commercial common property fishery. An estimated 51 million fish, or 34% of the commercial common property harvest (CPH), were produced by the Alaska salmon hatcheries. Approximately seven million salmon were harvested for hatchery cost recovery. The return of hatchery salmon provided an estimated $113 million, or 20% of the ex-vessel value of the statewide commercial CPH.

Prince William Sound and Southeast Alaska (SEAK) are the predominant regions affected by the enhancement program, and pink and chum salmon are the predominant species produced. In 2012, hatchery production accounted for 80% of the commercial fishery harvests in Prince William Sound and 27% in SEAK (Vercessi, 2013). Hatcheries in Cook Inlet supporting the ocean-ranching program are located at Port Graham, Tutla Bay, Elmendorf, and Fort Richardson. Hatcheries in the Kodiak region are located at Kitoi Bay and Pillar Creek.

The fisheries enhancement program accounted for approximately 2% of the sockeye salmon and 6% of the pink salmon in the 2014 commercial CPH, and contributed an estimated $547,000, or 2%, of the ex-vessel value of salmon in the commercial CPH. Cook Inlet area noncommercial fisheries CPH of 42,596 fish was dominated by sockeye salmon, with an estimated 27,000 hatchery-produced fish harvested (Vercessi, 2014).

In 1988, the Alaska Legislature changed the state's aquatic farming laws to allow shellfish and sea-plant farming on all state land except park land. Additional changes were made in 1997 that allowed the ADNR to enter directly into a lease for an aquatic farm site. An aquatic farm lease is a 10-year property right granted by the ADNR that allows a lessee to develop the state's tide and submerged lands into a shellfish or sea-plant farm. Currently, finfish farming is not allowed in Alaska. Locations of fish hatcheries and aquatic farms in the Cook Inlet and Kodiak Island regions are shown on Figure 3.2.2-2.

3.3.2.6. Fishermen's Contingency Fund

Commercial fishing gear sometimes is damaged, destroyed, or lost as a result of oil and gas operations on the OCS. Some compensation laws have been established over the years to protect fishers from certain occupational risks that could relate to offshore oil production. These include the Alaska Fisherman's Fund, the Oil Spill Liability Trust Fund (OSTLF), and the Fisherman's Contingency Fund. The Fisherman's Contingency Fund is the most relevant, because it pays commercial fishers for damaged gear and other economic losses caused by oil and gas obstructions in Federal waters where damage is not attributable to a single entity. The regulations at 50 CFR 296 establish procedures for administering the fund and for filing, processing, reviewing, adjudicating, and paying claims. There are, however, several qualifications. Most significantly, Federal regulations require claimants to prove that damages have resulted from underwater obstructions related to offshore oil and gas activities. Any structure visible on the surface of the water that could be avoided by a prudent fisher does not qualify as an "obstruction." In fact, any damage that occurs within a quarter-mile radius of any charted surface obstruction such as an oil platform is ineligible for compensation. No claims have ever been filed from the Alaska OCS region and, therefore, oil and gas companies in the area currently do not pay annual assessments into the fund.

3.3.3. Subsistence Harvest Patterns

3.3.3.1. Introduction

Stephen R. Braund and Associates (SRB&A) (2006) discuss subsistence as "… part of a rural economic system, called a 'mixed, subsistence-market' economy, wherein families invest money in small-scale, efficient technologies to harvest wild foods." The "mixed" economy is not unique to rural Alaska and is far from a single or simple entity. Cultural aspects of subsistence use patterns such as sharing among extended kin groups are a vital part of the subsistence way of life in rural Alaska.

For the remote rural economy of Alaska, subsistence is the central focus of the culture, economy, and way of life of rural residents (Goldsmith, 2007). The importance of subsistence was reflected in high levels of participation, high harvest levels which produced a large portion of the local food supply, extensive sharing of subsistence harvests through kinship and other networks of barter and customary trade, and large investments of time and money in subsistence equipment, supplies, and activities. Standard economic measures undervalue the significance of subsistence activities and the well-being of rural Alaskan residents.

Many of the communities adjacent to the proposed Lease Sale Area participate in subsistence. While new elements have been added to the way people live, this subsistence way of life is a continuation of centuries-old traditional patterns. The Federal definition of subsistence in the Alaska National Interest Lands Conservation Act (ANILCA) of 1980 is as follows: ''subsistence uses'' means the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade. (16 U.S.C. 3113)

3.3.3.2. Cultural Importance of Subsistence

Subsistence activities are assigned the highest cultural values by local Cook Inlet Dena'ina, Alutiiq, and Koniag peoples, and provide a sense of identity in addition to being an important economic pursuit. Many species are important for the role they play in the annual cycle of subsistence resource harvests, and effects on subsistence can be serious, even if the net quantity of available food does not decline. Subsistence resources provide more than dietary benefits. They also provide materials for personal and family use, and sharing resources helps maintain traditional family organization (Boraas, 2013). Subsistence resources provide special foods for religious and social occasions. The sharing, trading, and bartering of subsistence foods structures relationships among communities while at the same time, the giving of such foods helps maintain ties with family members elsewhere in Alaska (Magdanz et al., 2007).

3.3.3.3. General Characteristics of Subsistence Harvest Patterns

This section provides general information about subsistence harvest patterns, harvest information by resource and community, timing of the subsistence harvest cycles, and harvest area concentrations by community. Subsistence hunting, fishing, and trapping occur year-round throughout the entire region on land, in rivers, and on coastal waters. Subsistence foods include salmon and other fish, big game, small game and furbearers, marine mammals, birds and eggs, marine invertebrates, and plants and berries. The harvest and use of these foods represent activities with substantial social and cultural meaning and economic importance, especially within Alaska Native communities. Subsistence activities tie communities together, and provide group identity and community stability.

This section describes subsistence harvest patterns of the Alaska Native Alutiiq, Koniag, and Dena’ina Athabascan and non-Native communities adjacent to the Cook Inlet proposed Lease Sale Area. The following summary description is an update of the 2003 MMS EIS for Lease Sales 191 and 199, augmented by information from studies over the last 30 years, including Alaska Salmon Alliance (2015); Fall and Koster (2014); Fall and Utermohle (1999); Fall, Foster, and Stanek (1984); Fall et al. (2000); Holen and Fall (2011); Hutchinson-Scarbrough et al. (2010); Marchioni, Zimpelman, and Koster (2015); Stephen R. Braund and Associates (1980); Reed (1985); Spangler, Spangler, and Norcross (2003); Stanek (1985); Stanek, Holen, and Wassillie (2007); USDOI, MMS (1995, 2003); Wolfe and Ellanna (1983); and Wolfe, Hutchinson-Scarbrough, and Riedel (2012). Table 3.3.3-1 presents information about communities, households, and subsistence inventories for communities in the proposed Lease Sale Area.

Table 3.3.3-1. Communities, Households, and Subsistence Inventories.

Community	2000 Households	2010 Households	Harvest Inventory Years																								
			1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Municipality of Anchorage																											
Anchorage	94,822	107,332						MM	MM	MM	MM		MM	MM	MM	MM	MM	MM	MM	MM	MM						
Cook Inlet, East																											
Anchor Point (1)	711	840																									
Clam Gulch (1)	67	91																									
Gray Cliff (1)																											
Happy Valley (1)	196	270																									
Homer	1,599	2,235						MM	MM	MM	MM		MM	MM	MM	MM	MM	MM	MM	MM	MM						All
Hope	77	97	All																								
Kachemak (1)	169	235																									
Kasilof (1)	180	232																									
Moose Pass	84	93											All														
Nanwalek	45	55	All	All	All	All	MM	MM	MM	MM	MM		MM/ BMW	MM	MM	All	MM	MM	MM	MM	MM						All
Nikiski (1)	1,514	1,689						MM	MM	MM	MM		MM														

Community	2000 Households	2010 Households	Harvest Inventory Years																								
			1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Nikolaevsk	96	107									All																
Ninilchik	320	412									All																
Port Graham	70	79	All	All	All	All	MM	MM	MM	MM	MM		MM/ BMW	MM	MM	All	MM	MM	MM	MM	MM						All
Seldovia Village and Seldovia City	196	195		All	All	All		MM	MM	MM	MM		MM/ BMW	MM	MM	MM	MM		MM	MM	MM						All
Soldotna (1)	1,465	1,720																									
Sterling (1)	1,676	2,254																									
Voznesenka	n.d.	n.d.									All		-	-	-	-	-	-	-	-	-	-	-				
Cook Inlet, West																											
Beluga	13	10																	All							All	
Tyonek	66	70				All			MM	MM	MM		MM	MM	MM	MM	MM	MM	All	MM	MM					All	
Kodiak Island Communities																											
Akhiok	25	19			All			MM	MM	MM	MM		MM	MM	MM	All	F/ MM	MM	MM	MM	MM						
Karluk	9	12	All	All				MM	MM	MM	MM		MM	MM	MM	MM	MM	MM	MM	MM							
Kodiak	1,996	2,039		All (2)	All	All		MM	MM	MM	MM		MM	MM	MM	MM	MM	MM	MM	MM	MM						
Larsen Bay	40	34	All	All	All	All		MM	MM	All	MM		MM	MM	MM	All	MM	MM	MM	MM	MM						
Old Harbor	79	84	All					MM	MM	All	MM		MM	MM	MM	All	MM	MM	MM	MM							
Ouzinkie	74	56	All	All	All	All		MM	MM	All	MM		MM	MM	MM	All	F/ MM	F/ MM	MM	MM	MM						
Port Lions	89	77				All		MM	MM	MM	MM		MM	MM	MM	All	F/ MM	MM	MM	MM	MM						
Upper Alaska Peninsula																											
Chignik Bay	29	41		All			CMB	CMB /MM	CMB /MM	MM	MM		MM	MM	MM	All	MM	MM	MM	MM	MM			CMB /F			
Chignik Lagoon	33	29					CMB	CMB /MM	CMB /MM	MM	MM		MM	MM	MM	All	MM	MM	MM	MM	MM			CMB /F			
Chignik Lake	40	27		All			CMB	CMB /MM	CMB MM	MM	MM		MM	MM	MM	All	MM	MM	MM	MM	MM			CMB /F			
Ivanof Bay	9	2					CMB	CMB /MM	CMB /MM	MM	MM		MM	MM	MM				MM	MM							
Perryville	33	38					CMB	CMB /MM	CMB /MM	MM	MM		MM	MM	MM	All	MM	MM	MM	MM				CMB /F			

Source: ADFG, Community Subsistence Information System (CSIS) (ADFG, 2015d).
Notes: (1) Not listed in ADFG, CSIS. (2) Includes Kodiak City, Kodiak USCG Station, and Kodiak Road. All = “comprehensive” baseline survey for all resources used for subsistence purposes. BMW = Birds and migratory waterfowl. MM = Marine mammals. F = Fish. CMB = Caribou, moose, bear.

3.3.3.4. Characteristics of Harvest Activities

Table 3.3.3-2 shows some characteristics of community subsistence harvests within the proposed Lease Sale Area. The relative locations of the communities listed in Table 3.3.3-2 are shown in Figures 3.3.3.1 – 3.3.3.7. The community subsistence harvests include total per-capita harvest in terms of edible wild food, and the percentage of households that used, harvested, received, and gave away subsistence resources. This subsistence harvest information indicates relative patterns of use over the survey years available. Specific characteristics of subsistence harvest activities by community can be found in Fall and Utermohle (1999); Fall and Walker (1993); Fall, Foster, and Stanek (1984); Fall, Hutchinson-Scarbrough, and Coiley (1995); Fall et al. (1996); Fall et al (2000);

Fall (2006); Hutchinson-Scarbrough et al. (2010); Krieg et al. (1996); Morris (1987); Reed (1985); Schroeder et al., (1987); Stanek (1985); Stanek, Holen, and Wassillie (2007); and Wolfe and Ellanna (1983).

Table 3.3.3-2. Community Characteristics of Subsistence Harvests.

Community	Year	Annual Per Capita Harvest (lb.)	Per Capita Resources (% of Households)	Harvested Resources (% of Households)	Received Resources (% of Households)	Give-Away Resources (% of Households)
Municipality of Anchorage						
Anchorage (1)	2012	17	-	-	-	-
Eastern Cook Inlet						
Anchor Point (1)						
Clam Gulch (1)						
Happy Valley (1)						
Homer (1)						
Hope	1990	111	100	94	90	74
Kachemak (1)						
Kasilof (1)						
Nanwalek	1990	181	100	100	100	97
	1991	259	100	100	100	100
	1992	279	100	100	100	94
	1993	305	100	100	100	97
	1997	254	100	100	100	90
	2003	393	100	100	100	100
Nikiski (1)						
Nikolaevsk	1998	133	100	89	78	73
Ninilchik	1998	164	99	96	92	73
Port Graham	1990	214	100	100	98	89
	1991	281	100	96	98	88
	1992	273	100	100	100	98
	1993	212	100	98	100	90
	1997	253	100	98	96	86
	2003	466	98	96	98	94
Seldovia	1991	205	98	92	96	85
	1992	145	98	94	95	85
	1993	184	95	95	86	78
Soldotna (1)						
Sterling (1)						
Voznesenka	1998	167	100	100	83	78
Western Cook Inlet						
Beluga	2006	204	100	100	100	86
Tyonek	2006	217	96	94	92	83
	2013	169.9	100	100	85.7	77.6
Kodiak Island Communities						
Akhiok	1992	322	100	100	96	83
	2003	185	100	100	91	82
Karluk	1990	402	100	94	100	88
	1991	269	100	100	100	100

Community	Year	Annual Per Capita Harvest (lb.)	Per Capita Resources (% of Households)	Harvested Resources (% of Households)	Received Resources (% of Households)	Give-Away Resources (% of Households)
Kodiak	1991	123	100	91	95	84
	1992	159	99	90	94	80
	1993	151	99	88	97	84
Larsen Bay	1990	344	100	97	94	83
	1991	295	100	92	97	92
	1992	353	100	89	89	95
	1993	451	100	92	100	88
	1997	370	96	88	77	81
	2003	326	100	92	92	72
Old Harbor	1991	391	100	100	98	95
	1997	300	100	100	95	79
	2003	357	100	98	100	79
Ouzinkie	1990	205	100	98	96	77
	1991	209	100	100	97	84
	1992	347	100	98	94	88
	1993	218	98	92	95	85
	1997	264	100	100	94	92
	2003	316	100	96	98	86
Port Lions	1993	331	100	100	100	91
	2003	221	100	98	98	91
Upper Alaska Peninsula						
Chignik Bay	1991	357	100	90	100	73
	2003	321	100	96	100	86
Chignik Lagoon	2003	389	100	94	94	88
Chignik Lake	1991	442	100	100	100	92
	2003	256	100	95	100	90
Ivanof Bay (1)						
Perryville	2003	518	100	100	100	100

Notes: (1) Not listed in ADFG, CSIS (ADFG, 2015d). * <1%.
Modified from: Fall and Koster (2014); Jones, Holen, and Koster (2015); USDOI, MMS 2003-055, Vol. III: Table III.C-7 (USDOI, MMS, 2003).

Subsistence harvests, measured in usable pounds per person per year (lb/person-yr), ranged from 38 lb/person-yr (17 kg/person-yr) in Kenai in 1982, to 863 lb/person-yr (391 kg/person-yr) in Karluk in 1982, the most representative survey years. By geographic area, harvest products among the upper Cook Inlet and Kenai Peninsula Alaska Native communities of Tyonek, Nanwalek, and Port Graham ranged from 122 lb/person-yr (55 kg/person-yr) in Port Graham in 1989, the year of the Exxon Valdez Oil Spill) to 305 lb/person-yr (138 kg/person-yr) in Nanwalek in 1993, with an average for the three communities of about 237 lb/person-yr (107 kg/person-yr). On a per capita basis, useable wild harvested products among the other Kenai Peninsula communities (Fritz Creek, Homer, Kenai, Nikolaevsk, Ninilchik, and Seldovia) ranged from 38 lb (17 kg) in Kenai to 205 lb (93 kg) in Seldovia, with an annual average of 110 lb (50 kg).

On Kodiak Island, the non-road connected communities (Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions) showed per capita harvests ranging from 89 lb (40 kg) in Ouzinkie in 1989 to 863 lb (391 kg) in Karluk, with an average for the communities of 330 lb (150 kg). Elsewhere on Kodiak Island (Kodiak City, Chiniak, and the Kodiak Coast Guard Station), the per capita harvests ranged from 115 lb (52 kg) in Kodiak to 217 lb (98 kg) in Chiniak, with an average of 154 lb (70 kg) for the three sites. The Alaska Peninsula communities (Chignik Bay, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville) had usable per capita harvests ranging from 188 lb (85 kg) in Chignik to 490 lb (222 kg) in Ivanof Bay, with an average of 341 lb (155 kg). The names Chignik and Chignik Bay are used interchangeably.

These data indicate that very large amounts of subsistence foods are harvested in each of these geographic areas. Extensive sharing is commonplace, as suggested in Table 3.3.3-2, by the high percentage of households in these communities that receive and give away subsistence resources. Table 3.3.3-3 shows the use of subsistence foods over a range of survey years as represented by the percentage of consumable resources in selected resource categories for these communities.

Table 3.3.3-3. Resource Percent of Total Subsistence Harvest Adjacent to Proposed Lease Sale Area.

Community	Year	Salmon	Non-Salmon Fish	Large Land Mammals	Small Land Mammals	Marine Mammals	Birds and Eggs	Marine Invertebrates	Plants
Municipality of Anchorage									
Anchorage									
Eastern Cook Inlet									
Anchor Point (1)									
Clam Gulch (1)									
Happy Valley (1)									
Homer (2)	1982								
Hope	1990	45	14	28	2	0	2	4	5
Kachemak (1)									
Kasilof (1)									
Nanwalek	1990	50	31	1	0	3	1	9	4
Nanwalek	1991	48	32	1	0	2	1	9	5
Nanwalek	1992	44	32	5	*	6	*	9	4
Nanwalek	1993	49	30	3	*	6	*	8	4
Nanwalek	1997	62	16	5	*	9	1	4	2
Nanwalek	2003	74	15	*	*	2	*	4	4
Nikiski (1)									
Nikolaevsk	1998	50	25	17	0	0	0	3	5
Ninilchik	1998	26	23	40	*	0	*	7	3
Port Graham	1990	44	43	*	*	2	*	7	3
Port Graham	1991	47	35	1	*	5	*	8	2
Port Graham	1992	39	40	2	0	6	*	9	4
Port Graham	1993	46	34	2	0	4	*	8	6
Port Graham	1997	57	30	*	*	4	*	5	4
Port Graham	2003	57	32	2	*	4	*	2	2
Seldovia	1991	31	33	14	*	0	*	15	6
Seldovia	1992	40	28	10	*	*	*	12	7
Seldovia	1993	35	24	13	*	*	*	18	8
Soldotna (1)									
Sterling (1)									
Western Cook Inlet									
Beluga	2006	43	18	30	*	0	3	*	5
Tyonek	2006	69	5	18	*	2	1	*	3

Community	Year	Salmon	Non-Salmon Fish	Large Land Mammals	Small Land Mammals	Marine Mammals	Birds and Eggs	Marine Invertebrates	Plants
	2013	69	8	14	1	1	1	*	6
Kodiak Island Communities									
Akhiok	1992	62	8	9	*	6	1	13	1
	2003	52	13	12	0	6	*	14	2
Karluk	1990	73	13	7	*	1	*	3	2
	1991	72	11	10	0	*	*	2	4
Kodiak	1991	37	26	22	*	*	*	9	5
	1992	46	31	9	*	*	*	9	3
	1993	32	40	15	*	0	*	6	7
Larsen Bay	1990	30	30	12	*	7	1	16	3
	1991	37	15	22	*	3	2	18	3
	1992	52	19	8	*	1	*	16	2
	1993	45	19	17	*	2	*	14	2
	1997	58	21	15	*	*	*	3	2
	2003	55	17	6	*	*	*	16	5
Old Harbor	1991	53	19	7	*	7	2	9	2
	1997	37	17	20	*	14	4	6	2
	2003	46	17	12	*	13	2	6	3
Ouzinkie	1990	37	33	11	*	5	4	7	3
	1991	42	26	15	*	3	3	6	4
	1992	61	17	5	*	3	2	8	2
	1993	47	17	11	*	7	3	10	5
	1997	48	25	10	*	5	5	3	4
	2003	41	35	6	*	4	4	4	5
Port Lions	1993	48	19	16	*	1	1	9	5
	2003	43	22	19	*	2	1	5	7
Upper Alaska Peninsula									
Chignik	1991	48	31	7	0	*	1	11	2
	2003	40	33	9	0	*	*	13	3
Chignik Lagoon	2003	50	12	18	0	0	*	16	3
Chignik Lake	1991	46	9	34	*	*	3	5	1
	2003	54	10	24	0	2	2	6	3
Ivanof Bay									
Perryville	2003	44	11	28	*	5	2	7	2

Notes: (1) Not listed in ADFG, CSIS (2015). (2) Representative year. * <1%.
Modified from: USDOI, MMS 2003-055, Vol. III: Table III.C-8 (USDOI, MMS, 2003)

Table 3.3.3-3 clearly indicates the importance of salmon for all communities, ranging in total subsistence harvest from 73% in Karluk (1990) to 26% in Ninilchik (1998). Big game (large land mammal) take occurs within the proposed Lease Sale Area, and ranged from 40% in Ninilchik (1998) to <1% in Port Graham (1997).

Marine mammal subsistence use has declined within these communities. For example, in Akhiok, subsistence use of marine mammals has declined from 30% in 1982 to 6% in 1992 and 2003, and from 25% in 1986 in Old Harbor to 14% in 1997 and 13% in 2003. Birds and eggs have represented a relatively small proportion (1 to 7%) of total consumable resources, whereas marine invertebrates represented a considerably larger proportion of total consumable resources, ranging from 18% in Ninilchik (1982) and Larsen Bay (1991), to 1% in Chignik Lake (1984).

Table 3.3.3-3 indicates the importance of subsistence fishing for Cook Inlet communities. The subsistence fisheries closest to Cook Inlet's major population centers include the Tyonek subsistence fishery on the western side of Cook Inlet and the subsistence fisheries in Kachemak Bay. Halibut also may be caught by residents of rural communities through the Federal Subsistence Halibut Program. Other subsistence fisheries include herring, bottomfish, and shellfish, described below. Additional fisheries that occur outside the non-subsistence use areas include whitefish in the Tyone River, and several locations for Dolly Varden and smelt. Subsistence regulations provide information on where specific fisheries occur, open fishing periods, and allowable gear type.

Cook Inlet also hosts educational fisheries, defined in state statute as a fishery meant to allow for education of future generations through the practice of fish harvest and utilization. In the Central Management District of upper Cook Inlet, there were recently seven groups permitted to conduct educational fisheries. These groups include the Kenaitze Tribal Group, Ninilchik Traditional Council, Ninilchick Native Descendants, Ninilchik Emergency Services, Anchor Point VFW, Kasilof Historical Association, and the Southcentral Foundation.

The ADFG issued 34,315 permits for upper Cook Inlet personal use (PU) fisheries in 2012. The estimated harvest in all the various fisheries was 640,757 salmon; 98% were sockeye. The 2012 harvest was the second highest in the history of these fisheries (Fall et al., 2014).

Geography of Harvest Activities

Figures 3.3.3-1 through 3.3.3-7 show the geography of harvest activities for the communities in the potentially affected area. Figure 3.3.3-1 depicts the inland and coastal resource harvest areas for Tyonek in upper Cook Inlet from 1985 to 2005. Figure 3.3.3-2 depicts the clusters of fish camps and set net sites located south of Tyonek (Fall, Foster, and Stanek, 1984; Stanek, Holen, and Wassillie, 2007). Resource-harvest areas for the communities of Nanwalek and Port Graham are shown in Figure 3.3.3-3. Residents from both communities use this area, although the English Bay area and Port Graham Rivers are used primarily by residents of the respective communities (Stanek, 1985).

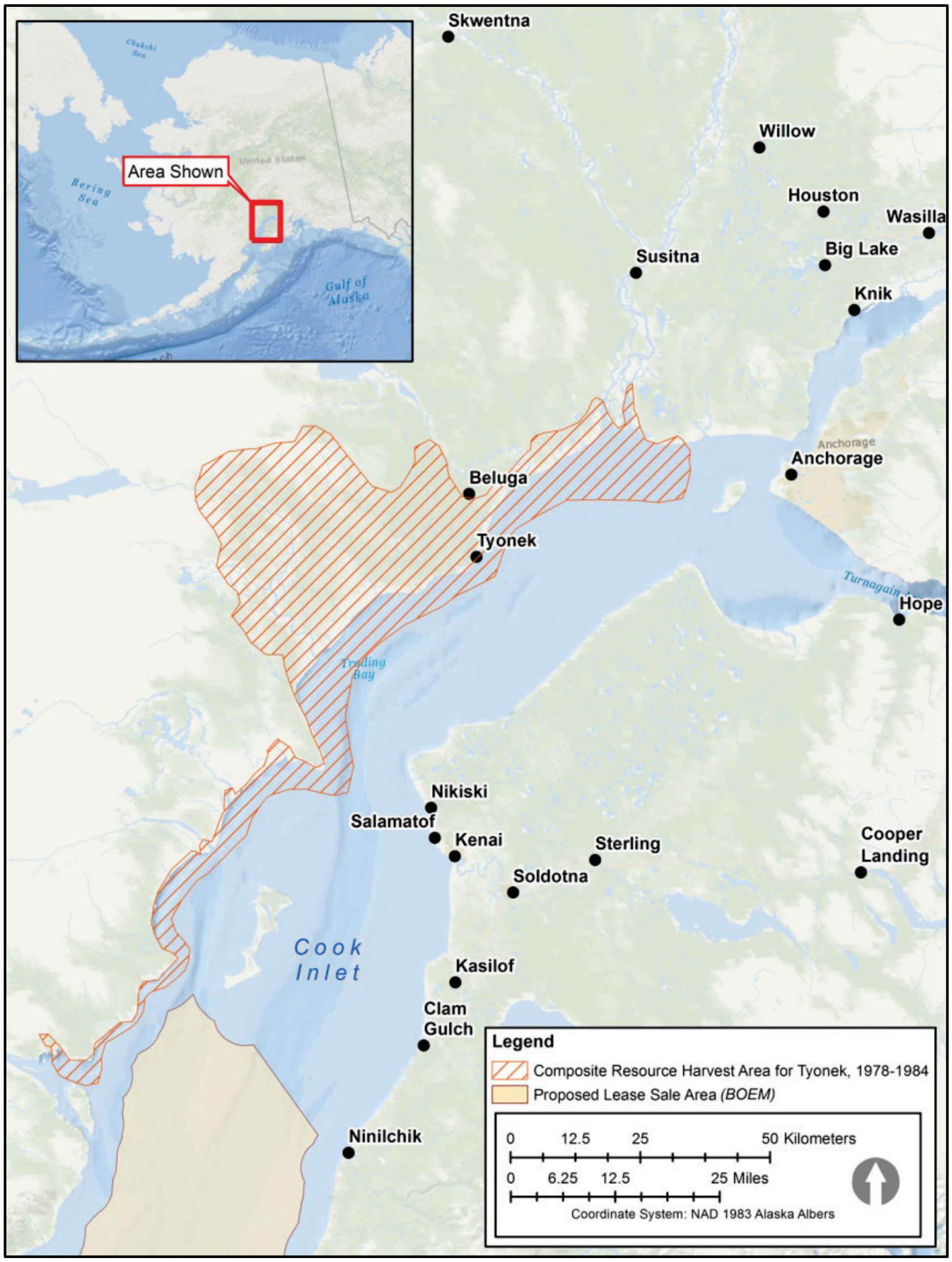


Figure 3.3.3-1. Composite Subsistence Resource Harvest Area, Tyonek. *(Source: Fall, Foster, and Stanek, 1984; Stanek, Holen, and Wassillie, 2007).*

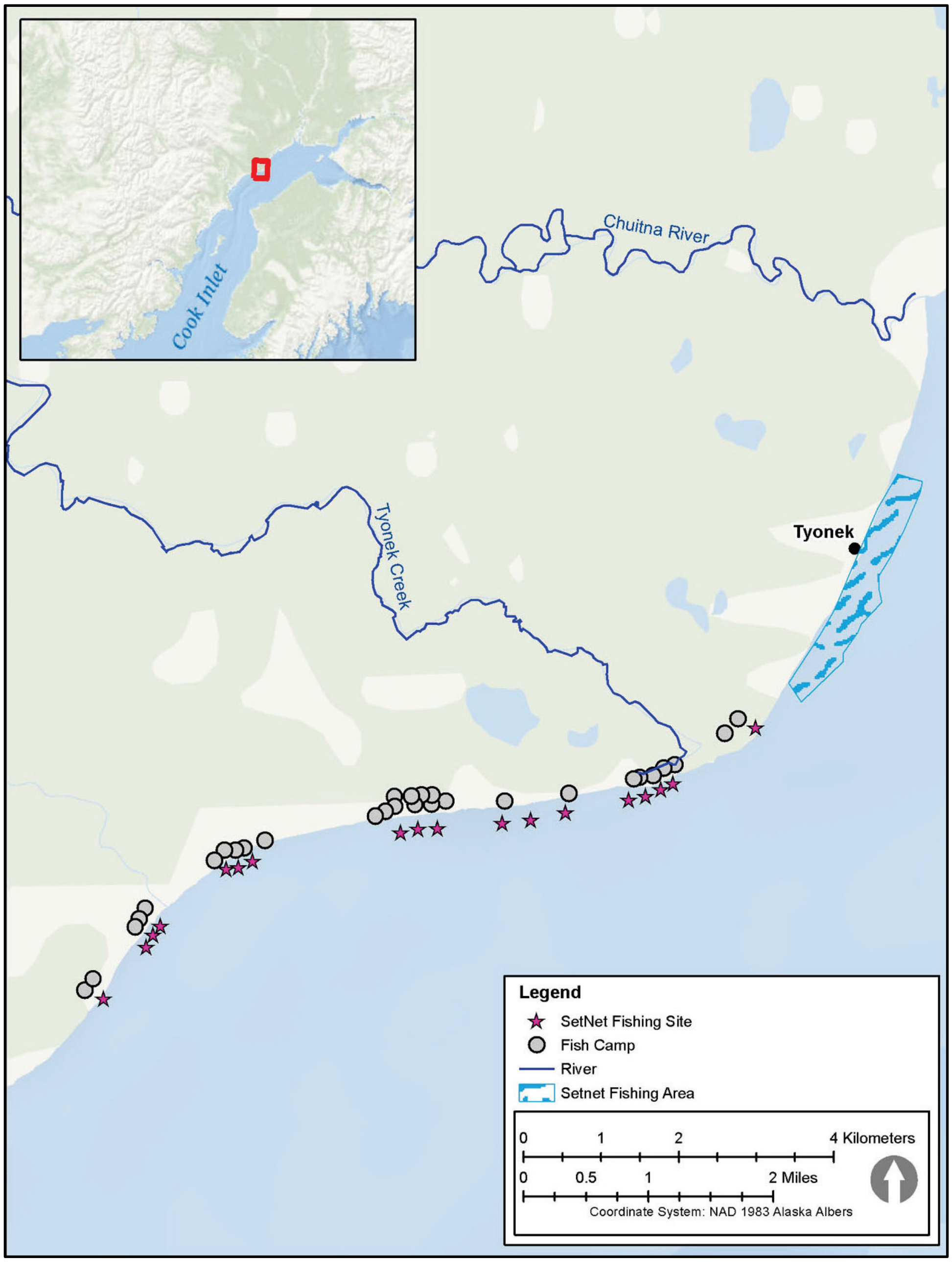


Figure 3.3.3-2. Subsistence Fishing Sites, Tyonek. *(Source: Fall, Foster, and Stanek, 1984; Stanek, Holen, and Wassillie, 2007).*

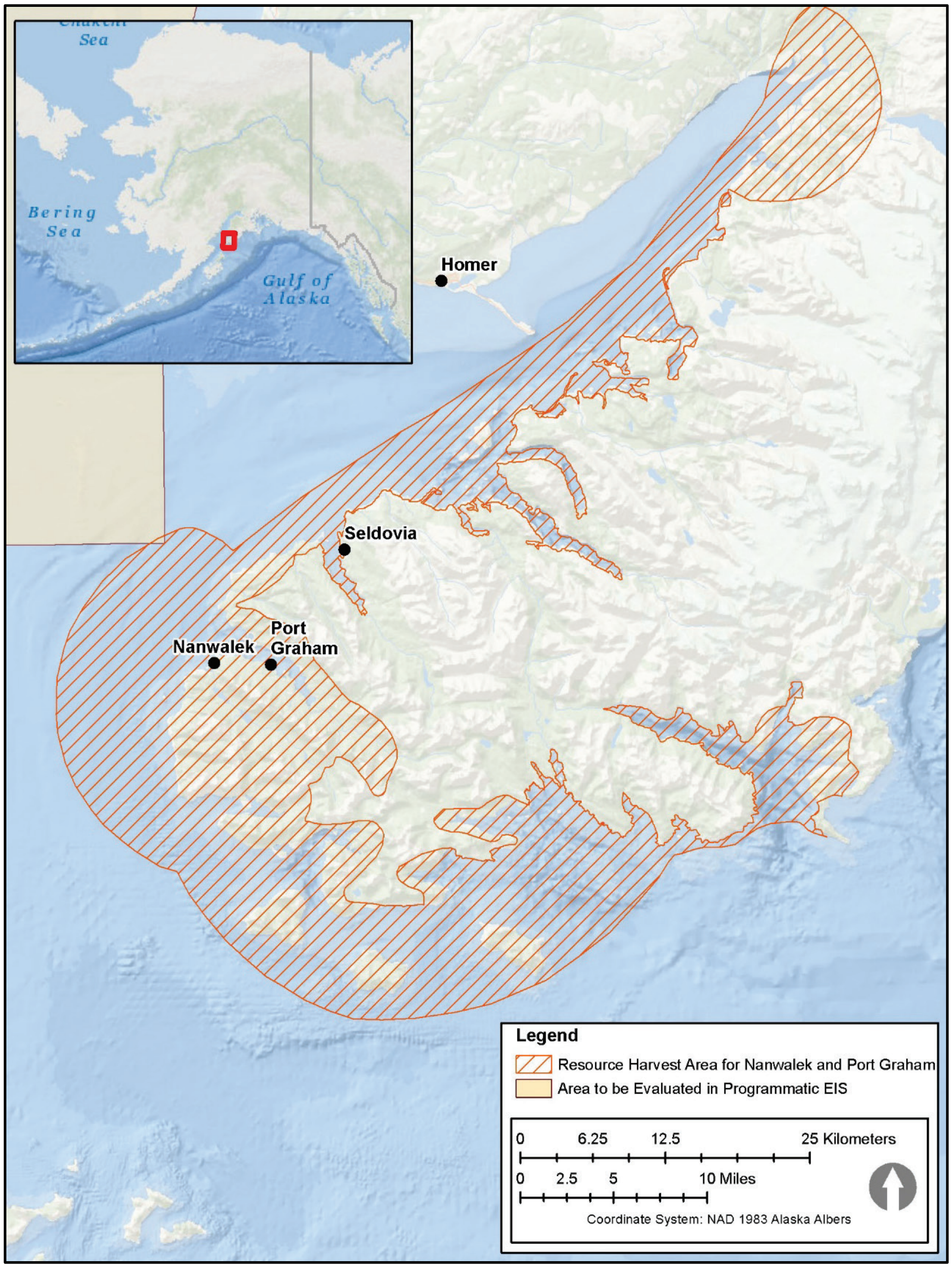


Figure 3.3.3-3. Subsistence Resource Harvest Areas, Nanwalek and Port Graham. *(Source: Stanek, 1985).*

Harvest areas are shown in Figures 3.3.3-4 and 3.3.3-5 for the six roadless communities on Kodiak Island: Akhiok, Old Harbor, Karluk, Larsen Bay, Port Lions, and Ouzinkie. Figure 3.3.3-6 shows the resource harvest areas used from 1962 to 1983 by residents of Chignik Bay and Chignik Lagoon, and Figure 3.3.3-7 shows the resource harvest areas used between 1962 and 1984 by residents of Chignik Lake, Ivanof Bay, and Perryville (Morris, 1987). Hutchinson-Scarbrough et al. (2010) present maps of subsistence salmon sites used by Chignik area communities. Subsistence survey information above represents either the date of the most recent subsistence survey in the community or the most representative survey year.

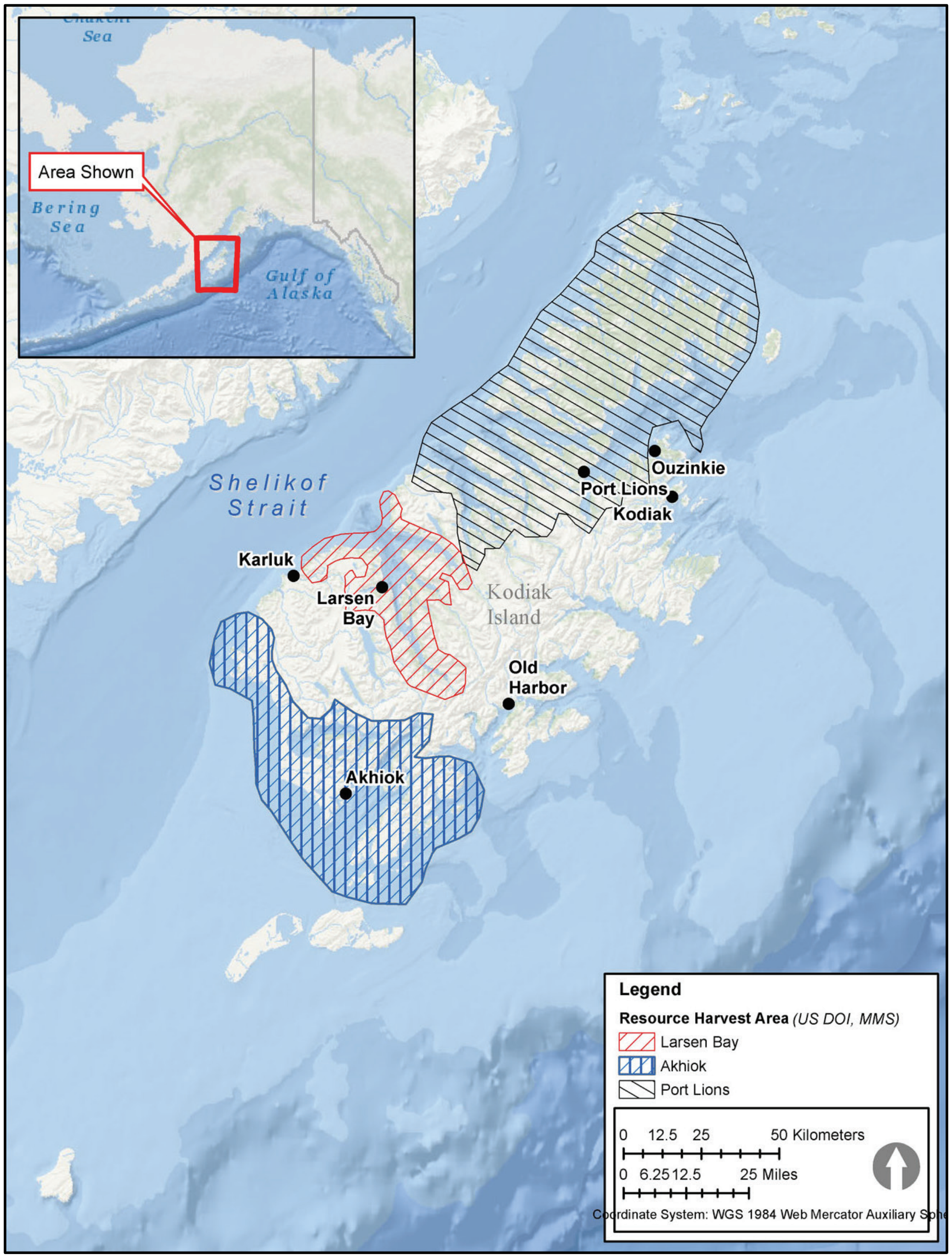


Figure 3.3.3-4. Subsistence Resource Harvest Areas, Ahkiok, Larsen Bay, and Port Lions, 1983.
(Source: Morris, 1987).

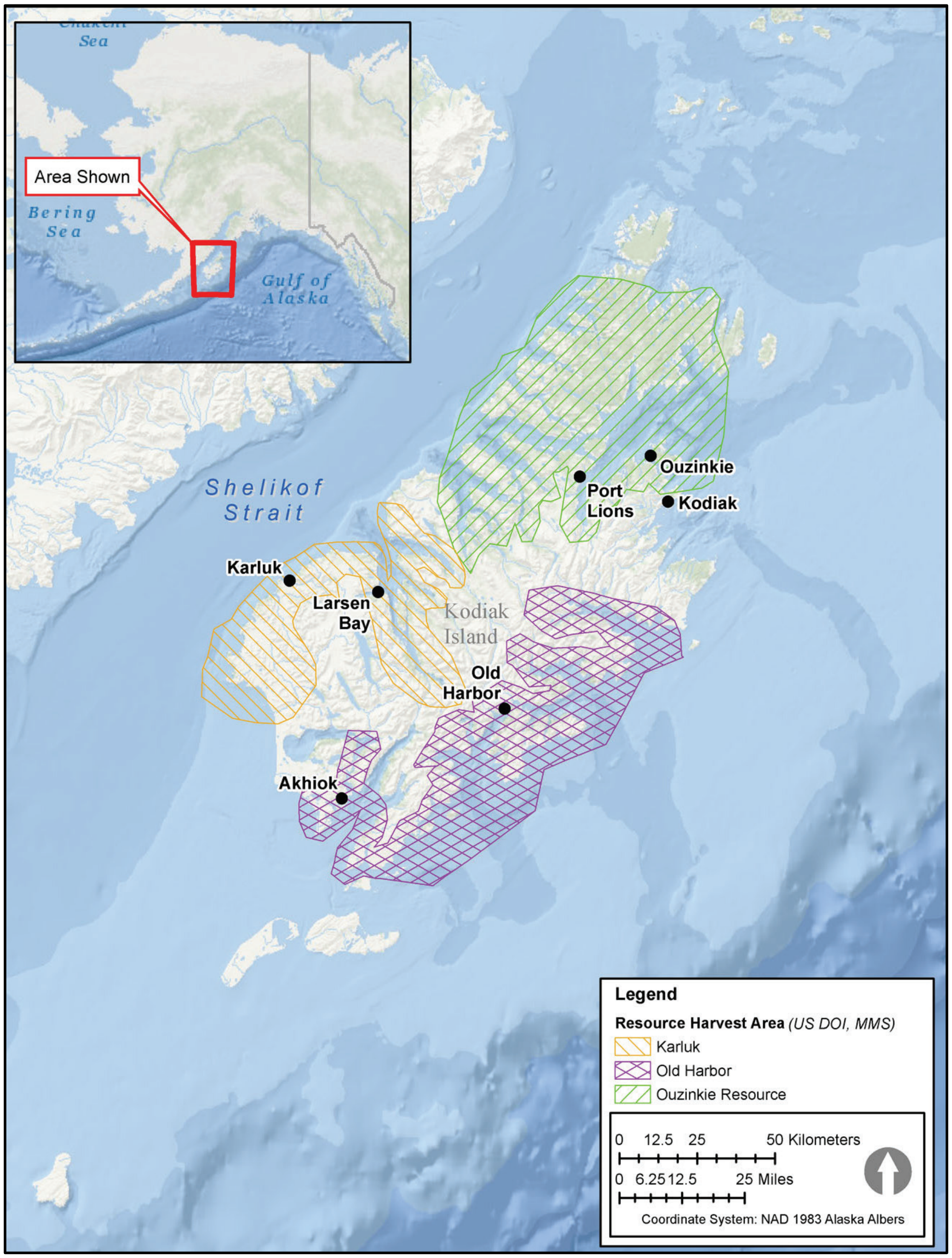


Figure 3.3.3-5. Subsistence Resource Harvest Areas, Karluk, Old Harbor, and Ouzinkie, 1983. *(Source: Morris, 1987).*

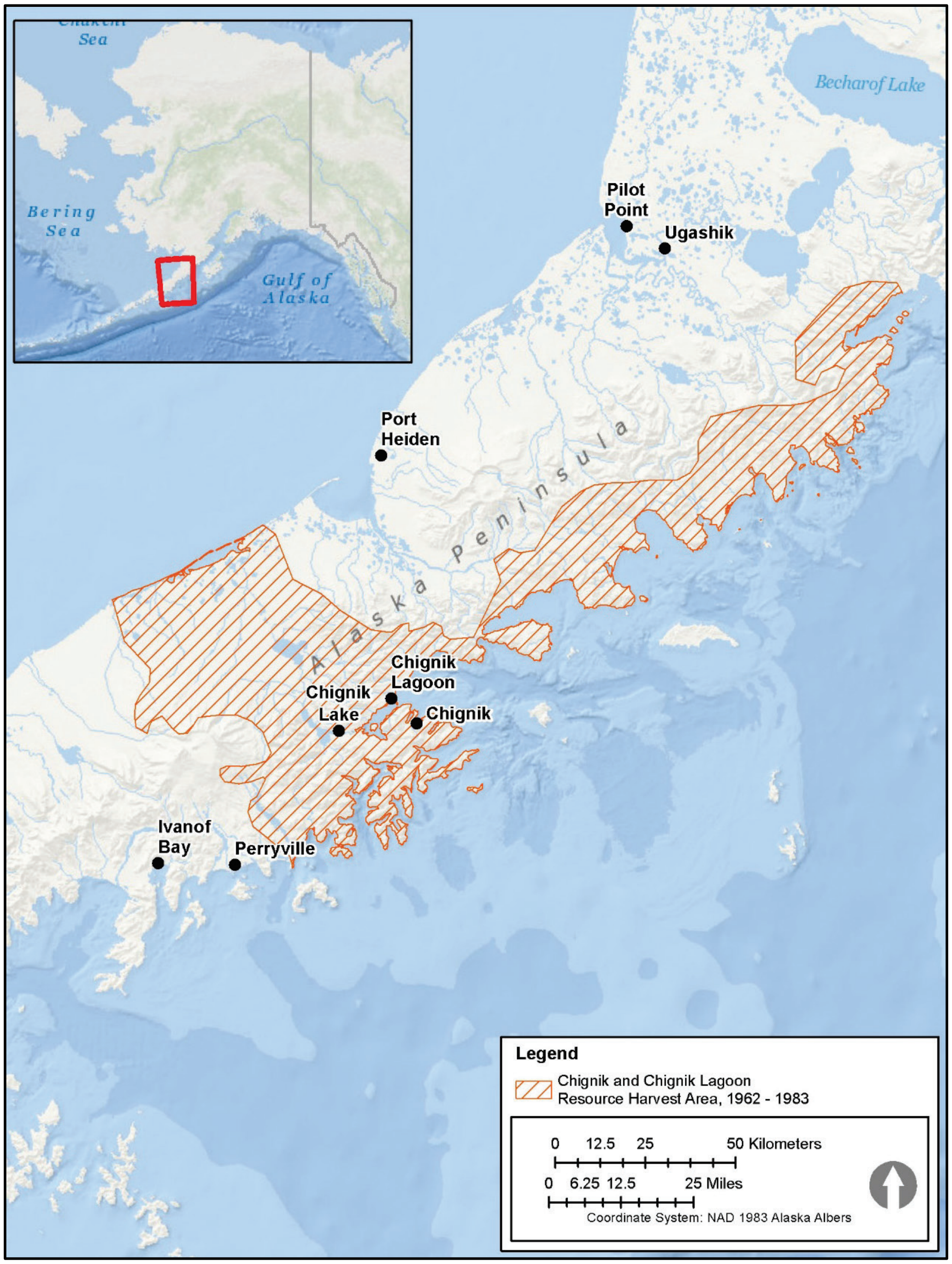


Figure 3.3.3-6. Subsistence Resource Harvest Areas, Chignik and Chignik Lagoon. *(Source: Morris, 1987).*

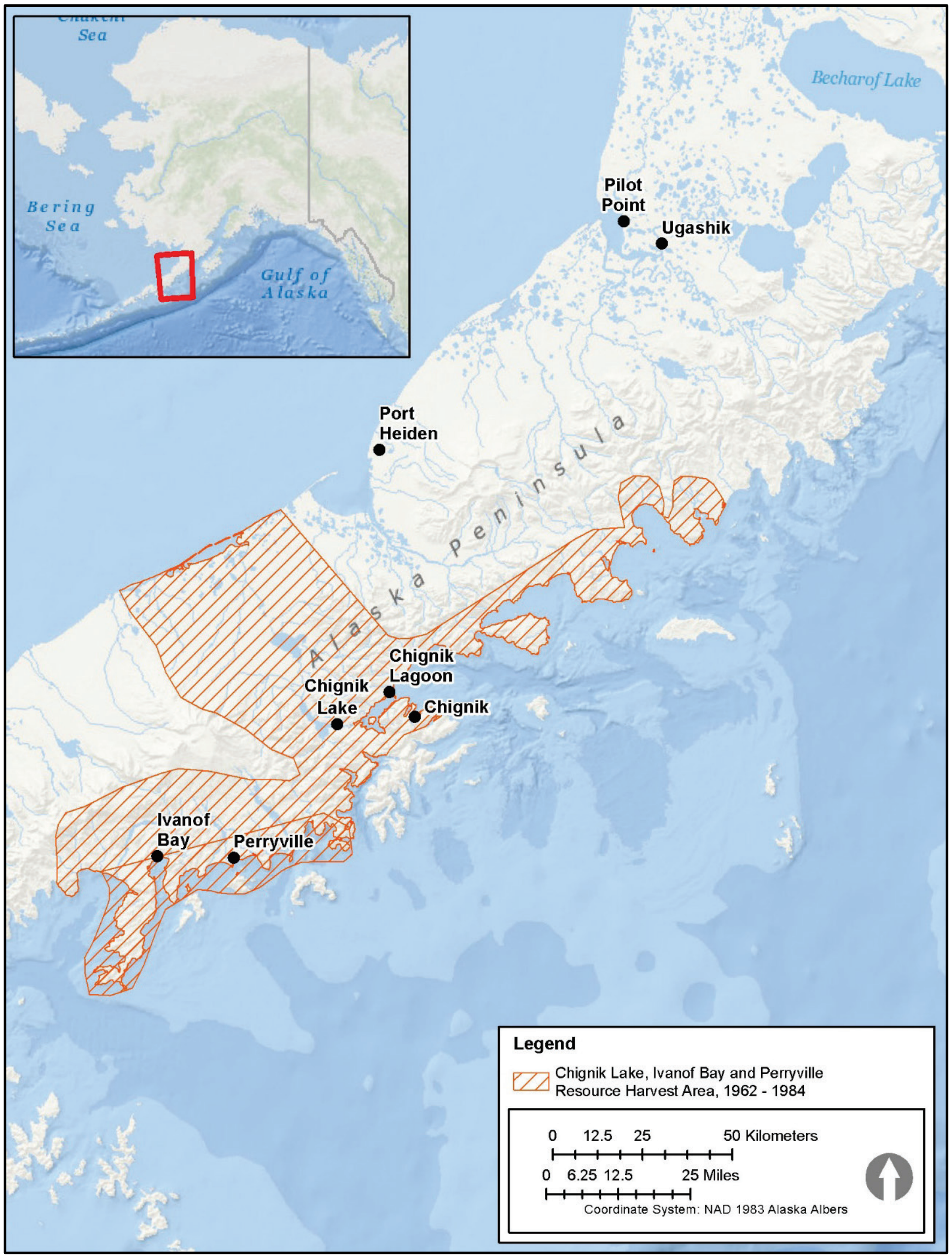


Figure 3.3.3-7. Subsistence Resource Harvest Areas, Chignik Lake, Ivanof Bay, and Perryville. *(Source: Morris, 1987).*

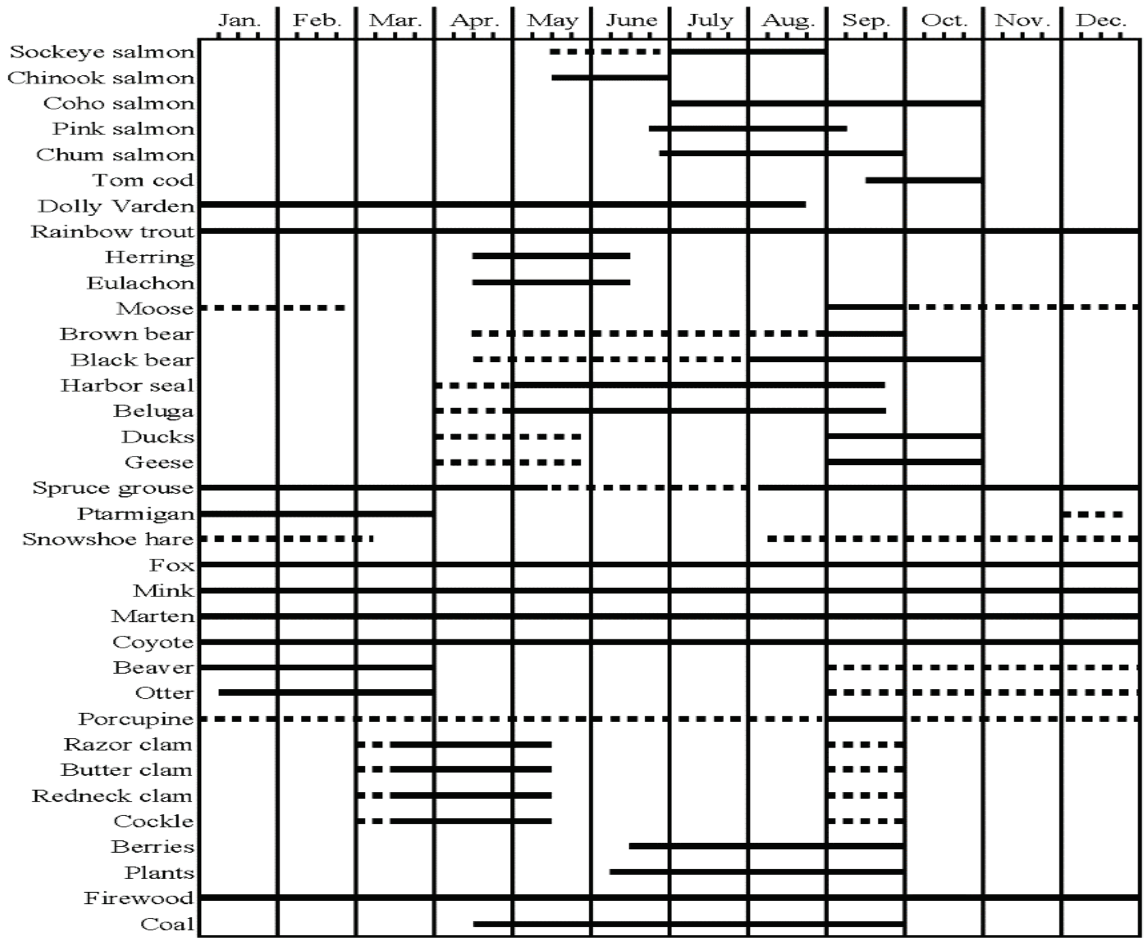
3.3.3.5. Subsistence Harvest Patterns

Regional-Level Subsistence Overview

Western Cook Inlet

Tyonek, on the western side of Cook Inlet, has a subsistence harvest area that extends from the Susitna River south to Tuxedni Bay; subsistence harvests are concentrated west and south of Tyonek (Figures 3.3.3-1 and 3.3.3-2). Moose and salmon are the most important subsistence resources measured by harvested weight, although important components of the harvest include non-salmon fish such as smelt, and waterfowl, and clams, along with a traditionally important beluga whale hunt

(Stanek, 1994). The annual round of harvests by Tyonek residents is depicted in Figure 3.3.3-8 (Jones, Holen, and Koster, 2015; Stanek, Holen, and Wassillie, 2007;).



Source: Foster (1982) as cited in Schroeder et al. (1987)

Solid line indicates when harvest takes place. Broken line indicates occasional harvest activity.

Figure 3.3.3-8. Annual Round of Harvest Activities in Tyonek.

Subsistence harvest of salmon is accomplished using a set gillnet fishery. The Tyonek annual subsistence harvest for salmon from 1980 to 2013 (the latter, the most recent available harvest data) is presented in Table 3.3.3-4. Due to their early arrival and large size, Chinook salmon are an important part of the subsistence harvest. Coho salmon are harvested for subsistence and commercial sale; sockeye, pink, and chum salmon harvests are important primarily for commercial sale. Salmon makes the largest contribution by weight to mean household harvest. Chinook salmon are cut into steaks, fillets, and strips for smoking; a variety of traditional products are made from the head, tail, fins, backbone, roe and milt sacks, heart, and stomach. The entire fish is used, and no portion is wasted (Holen and Fall, 2011; Jones, Holen, and Koster, 2015; Stanek, Holen, and Wassillie, 2007).

Table 3.3.3-4. Historical Tyonek Subdistrict Salmon Harvests, Permit Returns From 1980 to 2013.

Year	Permits		Chinook	Sockeye	Coho	Chum	Pink	Total
	Issued	Returned						
1980	67	67	1,757	235	0	0	0	1,992
1981	70	70	2,002	269	64	32	15	2,382
1982	69	69	1,590	310	113	4	14	2,031
1983	75	75	2,665	187	59	6	0	2,917

Year	Permits		Chinook	Sockey e	Coho	Chum	Pink	Total
	Issued	Returned						
1984	75	75	2,200	266	79	23	3	2,571
1985	76	N/A	1,472	164	91	10	0	1,737
1986	65	N/A	1,676	203	223	46	50	2,198
1987	64	61	1,610	166	149	24	10	1,959
1988	47	42	1,587	91	253	12	8	1,951
1989	49	47	1,250	85	115	1	0	1,451
1990	42	37	781	66	352	12	20	1,231
1991	57	54	902	20	58	0	0	980
1992	57	44	907	75	234	19	7	1,242
1993	62	54	1,370	57	77	17	19	1,540
1994	58	49	770	85	101	22	0	978
1995	70	55	1,317	45	153	15	0	1,530
1996	73	49	1,039	68	137	7	21	1,272
1997	70	42	639	101	137	8	0	885
1998	74	49	1,027	163	64	2	1	1,257
1999	77	54	1,230	144	94	11	32	1,511
2000	60	59	1,157	63	87	0	6	1,313
2001	84	58	976	172	49	6	4	1,207
2002	101	71	1,080	209	115	4	9	1,417
2003	87	74	1,183	111	44	10	7	1,355
2004	97	75	1,345	93	130	0	0	1,568
2005	78	66	982	61	139	2	0	1,184
2006	82	55	943	20	14	1	0	978
2007	84	67	1,281	200	123	2	3	1,609
2008	94	77	1,178	121	194	9	13	1,515
2009	89	69	636	184	258	2	1	1,081
2010	105	77	843	212	167	2	2	1,226
2011	114	63	595	154	26	7	7	789
2012	89	69	840	176	138	2	4	1,160
2013	82	48	813	172	181	0	19	1,185
5-year average (2008-2012)	**98**	**71**	**818**	**169**	**157**	**4**	**5**	**1,154**
10-year average (2003-2012)	**92**	**69**	**983**	**133**	**123**	**4**	**4**	**1,247**
Historical average (1981-2012)	**75**	**58**	**1,221**	**136**	**126**	**10**	**8**	**1,501**

Modified from: Fall et al. (2013); Holen and Fall (2011); Jones, Holen, and Koster (2015).
N/A – Not Available.

Salmon fishing begins in spring and early summer for all species, and coho fishing continues into October. Dolly Varden and rainbow trout are caught using rod and reel in local freshwater streams throughout the summer. September begins the harvest season for moose. Moose hunting is done locally from a network of logging roads, and by boat in regional river drainages. A prime location is Trading Bay. Fishing and gathering activities are normally combined with the moose hunt. After salmon, moose make the second-highest contribution by weight to the annual household subsistence harvest. Waterfowl are hunted at the mouths of Nikolai Creek, Middle River, and McArthur River. Harbor seals are hunted opportunistically along the shorelines of Trading and Redoubt Bays (Stanek, Holen, and Wassillie, 2007; Wolfe, Fall, and Ridel, 2008).

Federal marine mammal regulations allowed Alaska Natives to continue hunting Cook Inlet beluga whales until 2005 (Braund and Huntington, 2011). However, the Cook Inlet beluga population declined dramatically in the 1990s, from an estimated 1,300 animals to an estimated 340 individuals in 2014. Subsistence harvesters took only five whales between 1999 and 2005. Because the Cook Inlet beluga population has not recovered, no subsistence harvest has been allowed since 2006. Since

2008, Cook Inlet beluga have been listed as an endangered species. NMFS has designated critical habitat in Cook Inlet for these endangered whales (NOAA, 2009).

Wild celery, wild rhubarb, rosehips, and other plants are gathered in the summer. High- and low-bush cranberries, salmonberries, blueberries, and crowberries are harvested in the fall. Winter is a time of relatively low activity in the annual cycle of subsistence life for western Cook Inlet residents. Hunting for ptarmigan, spruce grouse, and hare continues throughout the winter. Some Tyonek residents trap furbearers from mid-November until the end of winter (Stanek, Holen, and Wassillie, 2007).

The use of fish and wildlife resources by residents of Beluga is similar to that of Tyonek with some notable exceptions. Beluga is a small, mostly non-Native community with an estimated 2005 to 2006 population of 40 people living in 15 year-round households. The annual round of harvests is similar to Tyonek's, but marine mammals are not harvested as the MMPA prohibits non-Natives from hunting marine mammals. There is no subsistence set net fishery for salmon (Stanek, Holen, and Wassillie, 2007). A Beluga River dipnet PU fishery began in 2008 on the lower portion of the Beluga River, and is open only to Alaska residents ≥60 years old.

Eastern Cook Inlet

The Federal Subsistence Board (FSB) designated Federal lands and waters in the Kenai area, including Kenai, Soldotna, Sterling, Nikiski, Salamatof, Kalifornsky, Kasilof, and Clam Gulch as non-rural, meaning that residents of these areas are not qualified to hunt, fish, or trap under Federal subsistence regulations on Federal public lands. The FSB also designated the Seward area including Seward and Moose Pass as non-rural. The state designated the Anchorage-Kenai-Matanuska Susitna region as a non-subsistence area; however, under state regulations, fishing for PU in non-subsistence areas may take place under sport, PU, and educational fishery regulations.

Kenai River Dipnet Fishery

This dipnet fishery is located in the lower Kenai River downstream of the Warren Ames Bridge, targeting sockeye salmon when escapement is >2 million fish. Only one Chinook salmon per permit was allowed to be kept through the 2013 season; no Chinook have been allowed to be kept since 2014. In 2012, estimated harvests totaled 535, 235 salmon, with 98% sockeye (526,992 individuals). For the 15-year period from 1996 to 2011, the average annual harvest was 231,864 salmon. Harvest quantities and resident Alaskan participation rose throughout that period (Fall et al., 2014).

Kasilof River Personal Use Set Net Fishery

This fishery at the mouth of the Kasilof River has an estimated total harvest of 15,970 salmon, with 15,638 (98%) sockeye. Average annual harvest from 1996 through 2011 was 20,111 salmon (Fall et al., 2014).

Kasilof River Dipnet Fishery

This dipnet fishery is located in the lower mile of the Kasilof River, but retention of Chinook salmon is currently prohibited. The 2012 estimated harvest was 75,648 salmon; 97% of them sockeye. For the 15-year period from 1996 through 2011, annual average harvest was 44,963 salmon (Fall et al., 2014).

Traditional Use Fisheries

The Kenaitze, a group of Dena'ina Athabascans, have made use of Cook Inlet natural resources for generations (Osgood, 1937). The Kenaitze have dried and smoked fish and picked berries without any direct relationship to size of personal income. A Kenaitze Tribal Fishery was first authorized by the Alaska Board of Fisheries (BOF) and managed by the ADFG in 1989. Fishing dates vary from year to year. Fishing occurs primarily in coastal marine waters at traditional fishing sites along the *Kahtnu* (Kenai), *Ggasilahtnu* (Kasilof) and *Yaghehtnu* (Swanson) Rivers, and 8,000 salmon are allowed per year. The Tribal Fishery is part of the tribe's educational curriculum, where youth, Elders and guests practice traditional methods of setting a net, identifying salmon species, cleaning fish, and preserving them for winter. The Kenaitze Tribe shares the fishery permit with members of the Salamatof Tribe.

Residents of Ninilchik subsist on fish resources, primarily salmon, that occur on the eastern side of Cook Inlet. Major harvested resources are salmon, halibut, butter clams, and razor clams. Established in 1993, the Ninilchik Traditional Council Fishery allows for a local subsistence salmon harvest. Fishing time varies but it is normally held from May 8 to September 30. The Federal Subsistence Board made a Customary and Traditional Use Determination (C&T) in January 2006 for Ninilchik residents for salmon, trout, Dolly Varden, and other char species in Federal waters within the Kasilof River watershed, and in 2007, on the upper Kenai River drainage.

Southern Kenai Peninsula

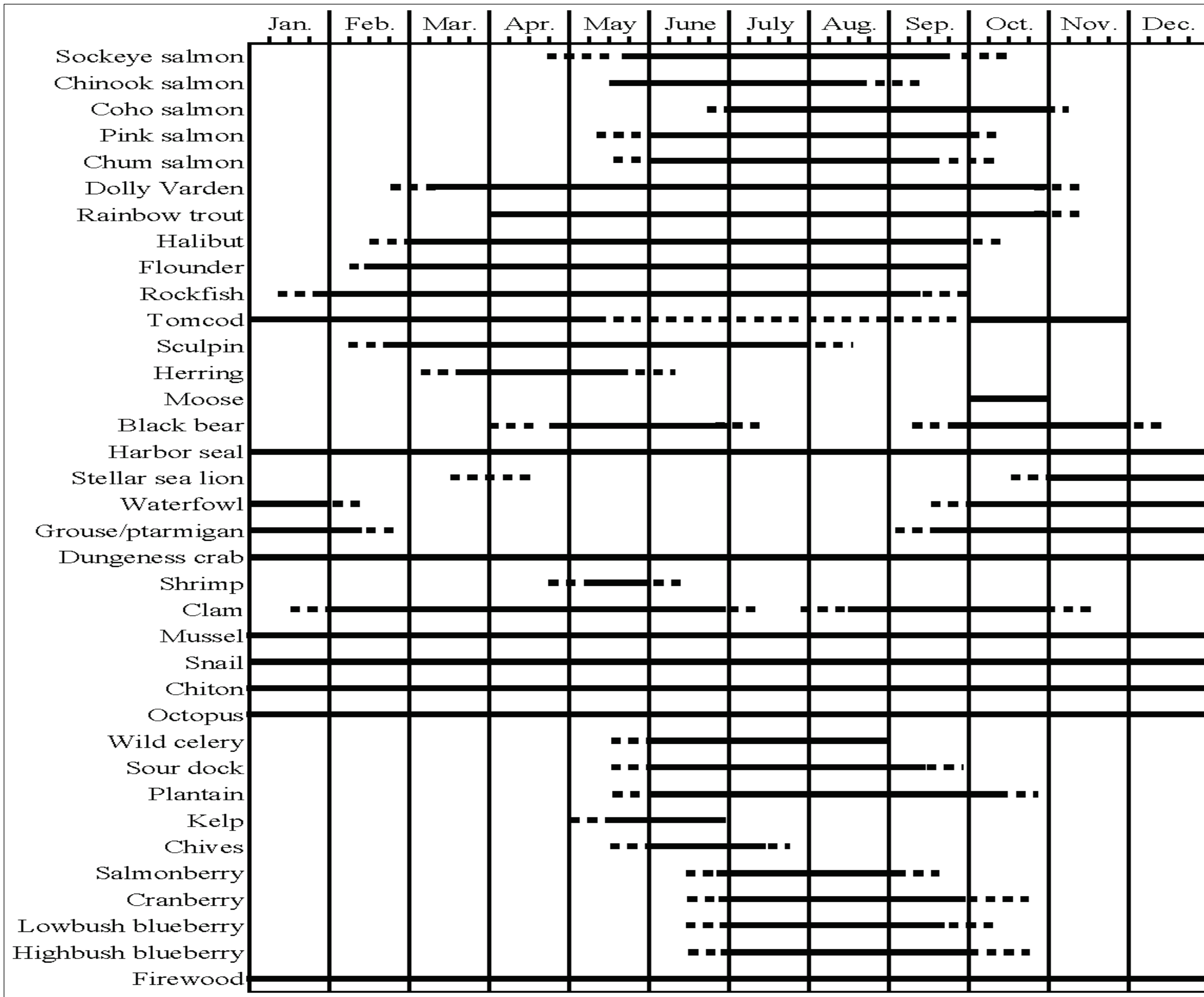
The FSB designated the Homer area, including Homer, Anchor Point, the North Fork Road area, Kachemak City, and Fritz Creek as non-rural, meaning that residents of these areas are not qualified to hunt, fish, or trap under Federal subsistence regulations on Federal public lands. Port Graham, Nanwalek, and Seldovia are considered rural communities by the FSB and state BOF and Board of Game (BOG). In non-rural (non-subsistence) areas, non-commercial set net fisheries authorized by the BOF take place under PU, or educational fisheries regulations.

Residents of Seldovia, Port Graham, and Nanwalek are the primary subsistence harvesters of the lower Kenai Peninsula. Because the Exxon Valdez Oil Spill fouled local traditional clamming areas, residents of Nanwalek and Port Graham have used the area around Ninilchik for the harvest of razor clams. Subsistence harvest of fish, wildlife, and vegetation occurs at the head and along the southern shore of Kachemak Bay (Figure 3.3.3-3). Area residents harvest seals, sea lions, and sea otters around Yukon Island and Tutka Bay (Wolfe, Fall, and Ridel, 2008). Primary waterfowl harvest areas are in the vicinity of Seldovia, Tutka, and China Poot Bays and the McKeon and Fox River flats. Seabirds and their eggs are harvested. Along local shorelines, moose and black bears are hunted. Port Graham and Nanwalek residents harvest salmon in Nanwalek and Koyuktolik ("Dogfish") Bays. Seldovia residents gather berries in larger quantities than any of the other Kenai Peninsula subsistence communities (Stanek, 1985; 2000).

Resources preferred by Nanwalek and Port Graham residents are clams, moose, bear, and especially salmon. These resources provide large quantities of food during a short period of the year and are preserved for use throughout the remainder of the year. A combination of commercial, subsistence, and rod-and-reel fisheries provide salmon for domestic use. Residents of Nanwalek and Port Graham participate in permitted general subsistence and PU fisheries that have existed in upper Cook Inlet since 1991. These fisheries are open to Alaska residents. PU dipnet fisheries take place on the Kenai and Kasilof Rivers and on Fish Creek. A set gillnet fishery takes place on the Kasilof River. A general Kachemak Bay subsistence and personal-use coho salmon fishery has taken place since before statehood. This fishery uses Fox River drainage salmon runs, and hatchery stocks returning to the fishing lagoon on Homer Spit and to Fox Creek. An enhanced Chinook salmon subsistence set gillnet fishery operates in Seldovia Bay.

Other resources, including trout, cod, halibut, chitons, snails, octopi, and crabs, generally are used fresh in season. Harbor seals and sea lions are highly valued marine mammals; they are harvested year-round and are extensively shared within the community. In 2008, Nanwalek residents harvested 38 harbor seals, and 1 sea lion; Port Graham residents harvested 17 harbor seals and 3 sea lions (Wolfe et al., 2009a, 2009b). A variety of plants are harvested in Kachemak Bay. Bull kelp, rockweed, and brown seaweed are collected from intertidal areas, and shoreline areas provide seaside plantain, rye grass, beach pea, wild parsley, and cow parsnip. A variety of local wild berries are picked; particularly low- and high-bush cranberries, rosehips, blueberries, moss berries, and wild raspberries. Seldovia, Kasitsna, and Jakolof Bays are important areas for harvest of marine invertebrates.

Locally harvested subsistence foods are distributed widely among community households. The annual round of harvests by residents of Nanwalek and Port Graham is depicted in Figure 3.3.3-9 (Stanek, 1985). Annual round figures indicate presence or absence of harvest during a particular quarter month through the year, but do not show intensity of effort. The composition of wild food harvested in six Kenai Peninsula Borough communities is depicted in Figure 3.3.3-10.



Source: Stanek (1985)

Solid line indicates when harvest takes place. Broken line indicates occasional harvest activity.

Figure 3.3.3-9. Annual Round of Harvest Activities, Nanwalek and Port Graham.

Kachemak Bay Set Net Coho Salmon Fishery

This fishery was a subsistence fishery along the shores of Kachemak Bay before being reclassified as a PU fishery in the early 1980s. The harvest guideline is 1,000 to 2,000 fish. The 2012 reported harvest was 1,894 salmon while a recent 10-year (2002 to 2011) average harvest for this fishery was 1,619 salmon (Fall et al., 2014).

Seldovia Subsistence Salmon Fishery

The BOF established this split season set gillnet fishery in 1995. The spring season targets Chinook salmon; the late summer season targets coho. Historical harvest data vary widely due to different season lengths and harvest targets of the years. The 2012 harvest was smaller than the 5-year (2007-2011) average of 217 salmon, the 10-year (2000-2011) average of 257 salmon, and the historical average of 248 salmon (Fall et al., 2014).

China Poot Dip Net Fishery

This PU dip net fishery for Alaska residents first opened in 1980, located approximately four miles southeast of Homer on the south side of Kachemak Bay. Sockeye salmon are targeted. Historical harvest data are available up to 1995; from 1980 to 1995, the historical annual average was 3,373 sockeye salmon (Fall et al., 2014).

Summary for Kenai Peninsula Communities

The nutritional contribution of the wild food harvest to communities in the Kenai Peninsula Borough is presented in Table 3.3.3-5. The wild food harvest in six Kenai Peninsula Borough communities is shown in Figure 3.3.3-10**.**

Table 3.3.3-5. Nutritional Contribution of Annual Wild Food Harvests to Kenai Peninsula Borough Communities.

Community	Survey Year	Annual Wild Food Harvest (lb/person)	Daily Wild Food Harvest (lb/person)	Recommended Dietary Allowance Protein (48 g/day)	Recommended Energy Requirements (2,317 K cal/day)
Anchor Point	Est	98.0	0.268	63%	9%
Bear Creek	Est	52.1	0.143	34%	5%
Beluga	Est/2006	259.9/204.0	0.712/0.559	168%	24%
Clam Gulch	Est	83.8	0.230	54%	8%
Cohoe	Est	83.8	0.230	54%	8%
Cooper Landing	1990	91.5	0.251	59%	8%
Crown Point	Est	110.7	0.303	72%	10%
Diamond Ridge	Est	93.8	0.257	61%	9%
Fox River	Est	105.4	0.289	68%	10%
Fritz Creek	1998	105.4	0.289	68%	10%
Funny River	Est	83.8	0.230	54%	8%
Halibut Cove	Est	183.6	0.503	119%	17%
Happy Valley	Est	98.0	0.268	63%	9%
Homer	1982	93.8	0.257	61%	9%
Hope	1990	110.7	0.303	72%	10%
Kachemak Bay	Est	105.4	0.289	68%	10%
Kalifornsky	Est	83.8	0.230	54%	8%
Kasilof	Est	83.8	0.230	54%	8%
Kenai	1993	83.8	0.230	54%	8%
Lowell Point	Est	52.1	0.143	34%	5%
Miller Landing	Est	93.8	0.257	61%	9%
Moose Pass	Est/2000	110.7/87	0.303/0.238	72%	10%
Nikiski	Est	83.8	0.230	54%	8%
Nikolaevsk	1998	133.0	0.364	86%	12%
Ninilchik	1998	163.8	0.449	106%	15%
Primrose	Est	110.7	0.303	72%	10%
Ridgeway	Est	83.8	0.230	54%	8%

Community	Survey Year	Annual Wild Food Harvest (lb/person)	Daily Wild Food Harvest (lb/person)	Recommended Dietary Allowance Protein (48 g/day)	Recommended Energy Requirements (2,317 K cal/day)
Salamatof	Est	83.8	0.230	54%	8%
Seward	Est/2000	52.1/97	0.143/0.266	34%/	5%
Soldotna	Est	83.8	0.230	54%	8%
Sterling	Est	83.8	0.230	54%	8%
Sunrise	Est	110.07	0.303	72%	10%
Nanwalek	1993/2003	304.9/393.22	0.834/1.077	197%	28%
Port Graham	1993/2003	212.3/466.35	0.582/1.278	137%	19%
Seldovia	1993	183.6	0.503	119%	17%
Tyonek	1993/2006	259.9/216.7	0.712/0.594	168%	24%

Notes: Est = Estimated harvest based on information from surveyed communities, using methods in Wolfe and Walker (1987). g/day = grams per day; K cal/day = kilocalories per day; lb = pounds

Source: Fall et al. (2002).

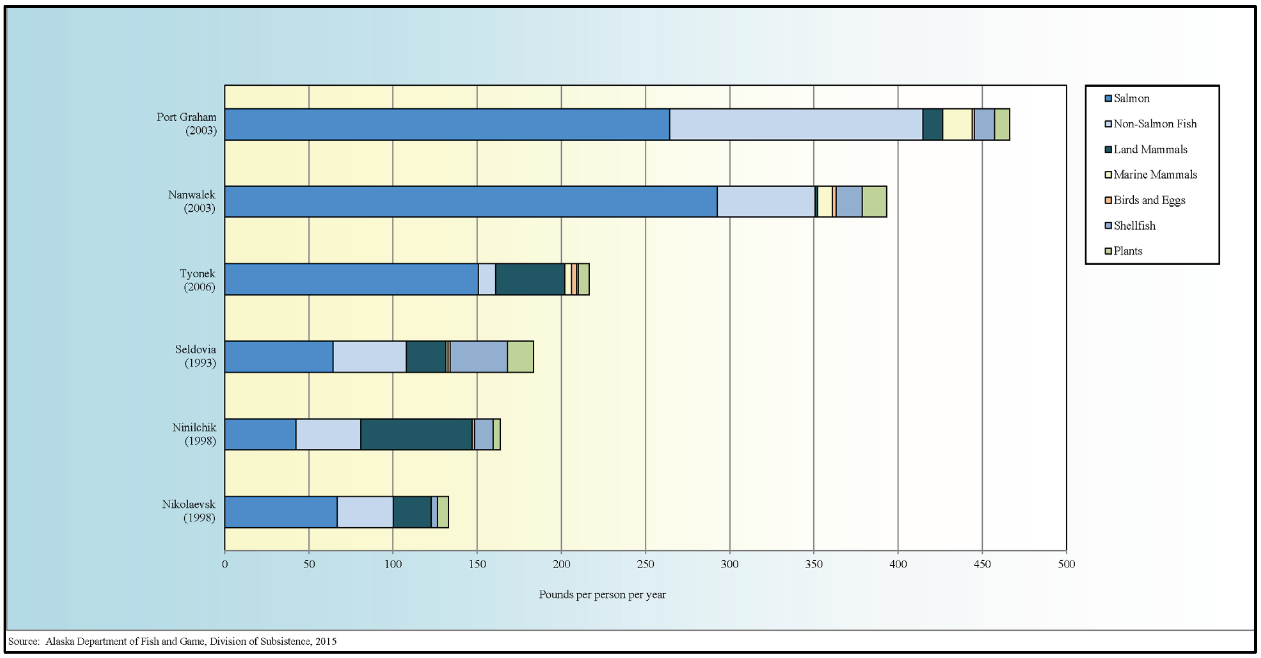


Figure 3.3.3-10. Composition of Wild Food Harvests in Six Kenai Peninsula Borough Communities.

Kodiak Island

The Kodiak Island Borough encompasses all of Kodiak Island including 11 incorporated places and Census Designated Places (CDPs). For subsistence management purposes, the portion of the Kodiak Island Borough population living along the road-accessible portions of the Kodiak Island Borough are distinguished from the seven incorporated places and CDPs located outside the range of the road system. Road-accessible communities include Kodiak City, the USCG base, Womens Bay, Chiniak, and the remainder of the road-accessible Kodiak Island Borough. Non-road-accessible communities on Kodiak Island include the predominantly Alaska Native communities of Ahkiok, Karluk, Larsen Bay, Old Harbor, Port Lions, and Ouzinkie. The Old Believer community at Aleneva CDP is not road-accessible.

The Kodiak Island Borough population living along the road system is the largest rural community in Alaska, as defined by the FSB and the Joint Board of Fish and Game, with a total population of some 14,135 in 2013 (USCB, 2014). The Kodiak Island communities not on the road system had a population of some 843.

The principal wild foods harvested and consumed by the communities of Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions in the Kodiak Island Borough are fish, 71% of the total annual harvest (salmon are 52%); land mammals (14%); and shellfish (6%). Salmon consistently provide the major portion of the region's subsistence food, and sockeye salmon is the most harvested. From 1985 to1999, the annual average harvest for the region ranged from 16,177 fish to 43,737 fish. Marine mammals make up 4%, plants 3%, and birds and eggs 2% of the total annual harvest by weight. Most commonly, the fish harvested by these communities are salmon, halibut, Pacific cod, Dolly Varden, and sablefish. Important land mammals taken are Sitka deer, moose, elk, and hare. Preferred marine mammals are the Steller sea lion and harbor seal. Tanner and Dungeness crabs and butter clams are the primary shellfish targeted. Figures 3.3.3-4 and 3.3.3-5 present information depicting the geographic harvest areas of these six communities.

The nutritional contribution of the wild food harvest to communities in the Kodiak Island Borough is presented in Table 3.3.3-6. The composition of wild food harvested in seven Kodiak Island Borough communities is depicted in Figure 3.3.3-11.

Table 3.3.3-6 Nutritional Contribution of Wild Food Harvests to Kodiak Island Borough Communities.

Community	Survey Year	Annual Wild Food Harvest (lb per person)	Daily Wild Food Harvest (lb per person)	Percentage of Recommended Dietary Allowance of Protein (48 g/day)	Percentage of Recommended Energy Requirements (2,317 K cal/day)
Akhiok	1992/2003	321.7/184.70	0.881/0.498	208%/–	29%/–
Chiniak	1982	217.2	0.595	140%	20%
Karluk	1991	268.7	0.736	174%	24%
Kodiak City	1993	151.1	0.414	98%	14%
Kodiak Road	1991	168.1	0.461	109%	15%
Larsen Bay	1993/2003	451/326.36	1.236/0.894	291%/–	41%/–
Old Harbor	1991/2003	391/357.16	1.071/0.978	253%/–	38%/–
Ouzinkie	1993/2003	218.4/315.64	0.598/0.865	141%/–	20%/–
Port Lions	1993/2003	331.5/221.43	0.908/0.607	214%/–	30%/–

Notes: Est = Estimated harvest based on information from surveyed communities, using methods in Wolfe and Walker (1987), g/day = grams per day; K cal/day = kilocalories per day; lb = pounds; – = data not provided.

Source: Fall et al. (2002).

Subsistence salmon and PU harvest surveys in the Kodiak Area show that salmon comprise over half of all harvested resources by weight, for subsistence in these communities. The 2012 estimated total subsistence salmon harvest was 28,159 salmon: 85% were sockeye, 10% coho, 4% pink salmon, 1% chum, and <1% Chinook salmon. This harvest was slightly lower than the 10-year (2002 to 2011) average of 34,188 estimated salmon harvested (Fall et al., 2014). For 2004 and 2005, the estimated average per capita harvests for salmon in five study communities –Akhiok, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions –were 185 lb and 152 lb, respectively (Williams, Coiley-Rippa, and Koster, 2010). Seines, gill nets, and rod and reel were used to harvest salmon.

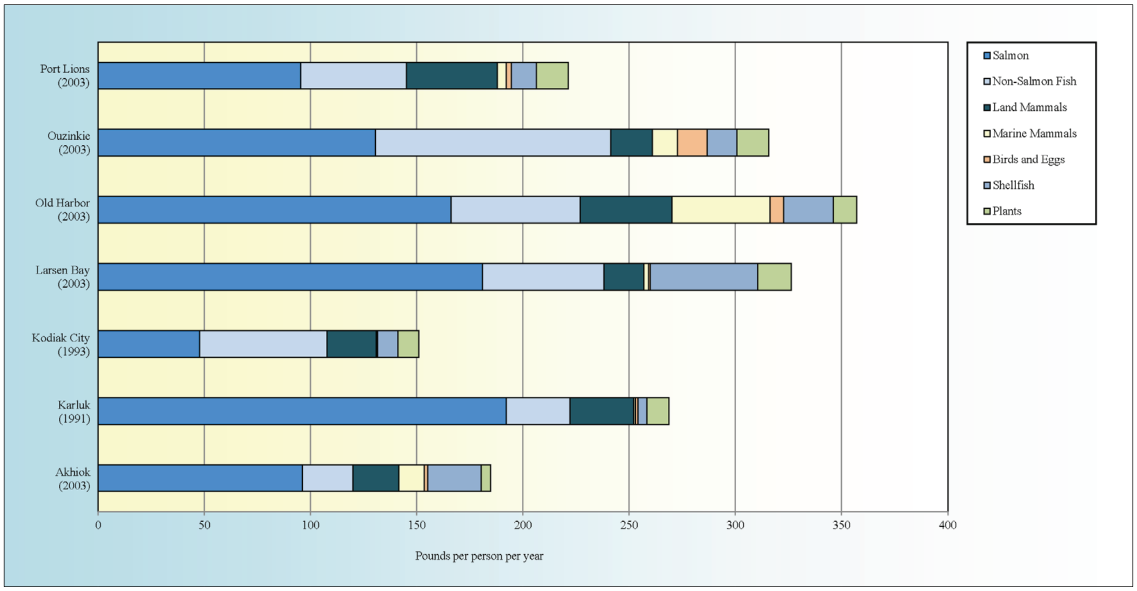


Figure 3.3.3-11. Composition of Wild Food Harvests in Seven Kodiak Island Borough Communities.

The Kodiak area has a tradition of subsistence harvests of marine invertebrates including shellfish such as king, Dungeness, and Tanner crabs, shrimp, and other miscellaneous shellfish. Crab are harvested using pots or ring nets, with construction details, seasons, permits, and bag and possession limits specified in regulations. Miscellaneous subsistence shellfish (shrimp, clams, chitons ("bidarkis"), octopi, etc.) are harvested with jigging gear, spears, net leads, and pots with construction details, seasons, permits, and bag and possession limits specified in regulations. While harvest data vary from year to year, and not all communities are surveyed every year, household surveys, and returned subsistence permits between 1995 and 2013 show an average of 8,058 king, Tanner, and Dungeness crab harvested in the Kodiak Management Area (Table 9 in Marchioni et al., 2015). In five Alaska Native communities (Akhiok, Larsen Bay, Old Harbor, Ouzinkie, and Ports Lions) some 14,919 lb of various shellfish were harvested according to a 2003 survey (Marchioni et al., 2015). These resources are shared extensively within and between households and communities.

Southern Alaska Peninsula

ADFG's Division of Subsistence has conducted subsistence research in the Lake and Peninsula Borough communities of Chignik Bay, Chignik Lagoon, Chignik Lake, Perryville, and Ivanof Bay (no longer occupied year-round) since the early 1980s. Baseline subsistence research was conducted in 1984 and 1989, including comprehensive harvest surveys and resource harvest and use area mapping (Fall and Utermohle, 1995; Morris, 1987). Subsistence salmon ethnographic research took place in 1990 (Hutchinson-Scarbrough and Fall, 1996); with comprehensive harvest surveys in Chignik Bay and Chignik Lake in 1991 (Hutchinson-Scarbrough and Fall, 1996; Krieg et al., 1996). In all communities except Ivanof Bay, comprehensive harvest surveys were conducted again in 2003, while only salmon were surveyed in 2011. Between 2010 and 2012, the Subsistence Salmon Ethnography Project conducted research in Perryville, Chignik Bay, Chignik Lake, and Chignik Lagoon (Hutchinson-Scarbrough, n.d.). From 2014 through 2016, the subsistence salmon harvest surveys and harvest area mapping will continue, culminating in a review of over 30 years of research and subsistence harvest changes and continuity (Hutchinson-Scarbrough and Marchioni, in prep.).

The principal wild foods harvested and consumed by the Alaska Native communities of Chignik Bay, Chignik Lagoon (Figure 3.3.3-6), Chignik Lake, Perryville, and Ivanof Bay (Figure 3.3.3-8) are fish, which comprise 58% of the total annual harvest by weight (with salmon accounting for 48%); land mammals (33%); and marine mammals (3%). Shellfish, plants, and birds and eggs each comprise 2%

of the total annual harvest. Most common fish harvested by these communities are salmon, halibut, herring, and Pacific cod. Important land mammals taken are caribou, deer, moose, and brown bear (Fall and Utermohle, 1995; Krieg et al., 1996; Morris, 1987).

Preferred marine mammals are harbor seals, sea lions, sea otters, and occasionally beached (primarily gray) whales. Primary shellfish harvest consists of Tanner and Dungeness crabs, littleneck and butter clams, chitons, cockles, and sea urchins. The nutritional contribution of the wild food harvest to Southern Alaska Peninsula communities is depicted in Table 3.3.3-8.

Table 3.3.3-7 Nutritional Contribution of Wild Food Harvests, Southern Alaska Peninsula Communities.

Community	Survey Year	Annual Wild Food Harvest (lb/person)	Daily Wild Food Harvest (lb/person)	% of Recommended Dietary Allowance of Protein (48 g/day)	% of Recommended Energy Requirements (2,317 K cal/day)
Chignik Bay	1991/2003	358/321.09	0.98/0.88	231%/–	33%/–
Chignik Lagoon	1989/2003	211/388.71	0.58/1.06	137%/–	19%/–
Chignik Lake	1991/2003	442/255.54	1.21/0.70	286%/–	40%/–
Ivanof Bay	1989	490	1.34	316%	45%/–
Perryville	1989/2003	394/517.96	1.08/1.42	255%/–	36%/–

Key: Est = Estimated harvest based on information from surveyed communities, using methods in Wolfe and Walker (1987). g/day = grams per day; K cal/day = kilocalories per day; lb = pounds; – = data not provided.
Source: Fall et al. (2002).

Salmon consistently provide the major portion of the region’s subsistence food, and sockeye is the most commonly harvested. From 1985 to 1999, the annual average harvest for the region ranged from 62,877 fish to 110,335 fish. Subsistence harvest surveys show that salmon comprise approximately 45% of all harvested resources by weight. Chignik Management Area (CMA) subsistence salmon permits are issued annually by CMA vendors with harvest reports due to ADFG by December 31. The 2011 estimated total subsistence salmon harvest was 13,732 salmon, of which 76% were sockeye, 13% coho, 8% pink salmon, with chum and Chinook salmon 1% each. This harvest was slightly higher than the historical average from 1977 to 2010 (11,270 estimated salmon harvested annually; Fall et al., (2013)).

3.3.3.6. Annual Cycle of Subsistence Activities

Table 3.3.3-1 shows the years that subsistence harvest inventories were published for communities and selected CDPs within that part of Alaska that potentially could be affected by the proposed action. These inventories generally were based on household sample surveys of annual subsistence harvests and contained information on usable weights of wildlife resources produced by resource type or species. The number of households enumerated in the 2000 and 2010 U.S. Censuses illustrate the size of the respective communities and to give a sense of the numbers of people harvesting subsistence resources.

Seasonal Round of Subsistence Harvests

For descriptive purposes, the generalized seasonal round begins in spring, which may be considered as the season when winter snows begin to melt, river and sea ice begin to break up, and open waters become available for migrating species such as waterfowl. Rod and reel fishing also may occur. Spring waterfowl seasons are legal for Alaska Native hunters in some locations and for some species. Under ice fishing may take place in early spring when ice on lakes and rivers is stable. Pelagic fishing for groundfish or hunting for marine mammals may occur. Brown bears may be harvested in spring in some communities on the Alaska Peninsula. Subsistence harvesters prepare gear for the summer fishing season. Firewood and beach coal is gathered year-round.

Summer is a season of intense wildlife harvests for commercial, sport, and subsistence fishers. Late spring and early summer clamming occurs on tidal flats throughout Cook Inlet. Early season runs of chum, pink, and Chinook salmon are harvested. Depending upon the location, runs of red, coho and Chinook continue throughout the summer. Salmon, herring, halibut, crab, shrimp, and other species are harvested, processed, and stored, or eaten fresh. As summer progresses, berries and greens ripen and are harvested, stored, or eaten fresh. Small game may be harvested opportunistically.

Fall is dominated by hunting. Large land animals such as moose, deer, caribou, and black and brown bears may be harvested. Harbor seals are hunted in the spring and fall, while Steller sea lion harvests are a fall activity. Small game harvests occur throughout the fall and winter. On lower Cook Inlet, Kodiak Island, and the Alaska Peninsula, communities' non-salmon fish may be harvested year-round, as are clams, crabs, and other shellfish.

Winter subsistence activities include small game hunting, winter moose or caribou hunts, and in ice-free waters, harvests of non-salmon fish and various shellfish. Late runs of sockeye salmon are harvested on Kodiak Island, as are Dolly Varden and steelhead. Harbor seal and Steller sea lions are harvested. Traplines to harvest furbearers are operated from late fall through winter until the close of trapping season, when furs are no longer in prime condition.

3.3.3.7. Harvests by Species Categories

Subsistence harvest information is available from several sources: (1) household and community harvest surveys; (2) information on permits returned by subsistence harvesters; (3) annual surveys focusing on particular resources. During the past several decades a variety of cooperative management and harvest monitoring/survey programs have developed in partnership between management agencies and subsistence harvesters. There is a dual management system for subsistence harvests in Alaska with sometimes overlapping Federal and state regulatory systems in operation. The Federal government regulates Federal subsistence fisheries and hunts on Federal public lands and federally reserved waters in Alaska. The state of Alaska regulates state subsistence fisheries and hunts on all Alaskan lands and waters.

Marine Mammals

Marine mammal harvests are managed by the Federal government. NMFS manages seals, sea lions, and whales. The USFWS manages polar bears, sea otters, and walruses. There is an exemption in the Federal MMPA to allow for the traditional harvest and use of marine mammals by coastal Alaska Native peoples. Marine mammal species of concern in the Cook Inlet region include beluga whales, harbor seals, Steller sea lions, and sea otters.

The Alaska Native Harbor Seal Commission (ANHSC) and the Aleut Marine Mammal Commission (AMMC) and regional Native associations, and local tribes and governments, together with state and Federal agencies, document the subsistence harvests of harbor seals and Steller sea lions by Alaska Native hunters. Depending on the availability of funding, harvest documentation may focus on a specific region, such as Kodiak Island for 2011 (Wolfe, Hutchinson-Scarbrough, and Riedel, 2012), southeast Alaska (Wolfe et al., 2013), or statewide. Subsistence harvests have been documented from 1992 through 2008, with no surveys in 1999 (Wolfe et al., 2001; Wolfe and Hutchinson-Scarbrough 1999; Wolfe and Mishler, 1993a, 1993b, 1994, 1995, 1996, 1997, 1998; Wolfe, Fall, and Stanek, 2002, 2003, 2004, 2005, 2006; Wolfe, Fall, and Riedel, 2008, 2009a,b).

Table 3.3.3-9 presents information on harbor seal and Steller sea lion harvests for communities in three regions proximal to the proposed Lease Sale Area from 1992 through 2011. Alaska Native groups in the proposed Lease Sale Area using harbor seals include the Aleut of the Alaska Peninsula and the Alutiiq of the Kodiak Archipelago. The Dena'ina of Cook Inlet occasionally harvest harbor seals. The Alutiiq in Kodiak Island communities are the primary users of sea lions (Wolfe, Fall, and

Riedel, 2009a,b). The communities of the southern Kenai Peninsula are not included in Table 3.3.3-9. See Section 3.3.3.5 for a description of marine mammal harvest for Nanwalek and Port Graham.

Table 3.3.3-8. Steller Sea Lion and Harbor Seal Harvests in Three Regions.

Community	1992						1993						1994					
	Sea Lion			Harbor Seal			Sea Lion			Harbor Seal			Sea Lion			Harbor Seal		
	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take
Upper Cook Inlet	5.7	3.8	9.5	51.6	0	51.6	7.8	3.3	11.1	49.2	5.6	54.8	1.4	0	1.4	16.2	0	16.2
Kodiak Island	41.5	16.3	57.8	225.5	13.1	238.6	41.5	16.9	58.4	171.7	20.1	191.8	57.1	4.2	61.3	168.2	3.6	171.7
South Alaska Peninsula	2.4	0	2.4	115.5	13.1	128.6	4.6	1.2	5.7	100	23.1	123.1	4.6	1.1	5.7	98.6	11.1	109.8

	1995						1996						1997					
	Sea Lion			Harbor Seal			Sea Lion			Harbor Seal			Sea Lion			Harbor Seal		
	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take
Upper Cook Inlet	0	0	0	3.7	0	3.7	3.3	0	3.3	64.3	8.8	73.1	0	0	0	101.7	8.8	110.5
Kodiak Island	127.9	7.7	135.7	223	9.2	232.2	53.9	6.3	60.2	185.2	4.9	190.1	33.3	4.9	38.2	189.8	18.3	208.2
South Alaska Peninsula	0	8.1	8.1	117	11.1	128	3.7	1.3	5	86.3	5	91.3	8.3	0	8.3	68.3	12.1	80.4

	1998						2000						2001					
	Sea Lion			Harbor Seal			Sea Lion			Harbor Seal			Sea Lion			Harbor Seal		
	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take
Upper Cook Inlet	0	0	0	79.2	13.5	92.7	0	0	0	79.2	13.5	79.2	1.3	0	1.3	91.2	2.7	93.9
Kodiak Island	14.5	3.3	17.8	174	3.7	177.7	18.5	0	18.5	185.9	7.3	193.2	32.8	2.2	35	155.6	4.8	160.4
South Alaska Peninsula	9.2	0	9.2	79.9	7.5	87.4	13.8	0	13.8	65.4	18.4	83.8	10.2	1.4	11.6	68.7	16.3	85.1

	2002						2003						2004					
	Sea Lion			Harbor Seal			Sea Lion			Harbor Seal			Sea Lion			Harbor Seal		
	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take
Upper Cook Inlet	0	0	0	75.2	8	83.2	0	0	0	9.8	15	105.8	0	0	0	56.6	13.4	69.9
Kodiak Island	16.1	0	16.1	152.1	10.2	162.3	30.3	5.7	36	172.7	13	185.6	13.5	3.5	17	172.2	15.7	188
South Alaska Peninsula	3.9	4.2	8.1	70	19.4	89.4	2.5	2.4	5	91.1	13.5	104.5	3.9	0	3.9	77.9	10.1	88

	2005						2006						2007					
	Sea Lion			Harbor Seal			Sea Lion			Harbor Seal			Sea Lion			Harbor Seal		
	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take
Upper Cook Inlet	0	0	0	37.6	13.3	50.9	0	0	0	37.6	13.3	50.9	0	0	0	27	4	31
Kodiak Island	21.9	3.2	25.1	305.1	10.6	315.7	7	0	7	210.3	10.2	220.5	15.8	3.5	19.3	198.6	5.8	204.4
South Alaska Peninsula	4.2	0	4.2	66.8	8.5	75.3	17.5	1.1	18.5	52.5	20.6	73	9.7	0	9.7	88	18.4	106.4

	2008						2011					
	Sea Lion			Harbor Seal			Sea Lion			Harbor Seal		
	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take	Harvest	Struck/Lost	Total Take
Upper Cook Inlet	0	0	0	33.1	3.5	36.7						
Kodiak Island	12.1	6.7	18.8	165.5	26.5	192	19.7	0	19.7	145.6	17.7	163.3
South Alaska Peninsula	7.2	1.4	8.6	107.5	17.3	124.8						

Notes: No survey data for years 1999, 2009, 2010. Survey Year 2011 surveyed Kodiak Island only. Units are whole animals, or estimates, where fractions are listed. Upper Cook Inlet, Kodiak Island, and South Alaska Peninsula regions include more communities than the land areas immediately adjacent to the proposed Lease Sale Area.

Modified from: Wolfe, Fall, and Riedel, 2009a,b; Wolfe, Hutchinson-Scarbrough, and Riedel, 2012.

Historically, most beluga whales were harvested in upper Cook Inlet by Dena'ina. Mahoney and Shelden (2000) present harvest data gathered from a range of sources; the NMFS FSEIS (2008a) for subsistence hunting presents data through 2007. There have been, at most, one or two beluga harvested annually since 2000, when hunting restrictions were imposed on this endangered stock. The Alaska and Inuvialuit Beluga Whale Committee (ABWC) and the Cook Inlet Marine Mammal Council (CIMMC) are cooperating stakeholders with management agencies and other interested parties working to bring about the recovery of the Cook Inlet beluga population. Harvests of other marine mammal species are rare.

Terrestrial Animals

The ADFG, Division of Wildlife Conservation (ADFG, DWC), surveys and inventories wildlife populations to inform management decisions. Harvest information is recorded from a variety of sources including returned permits and harvest tags, hunter surveys, and information from commercial activities such as guiding and trapping. While ADFG, DWC does not manage waterfowl or marine mammals, it provides input and assistance to Federal management agencies and stakeholder groups. ADFG, Division of Subsistence conducts subsistence harvest surveys for all subsistence species. Harvest data are available through the Community Subsistence Information System (CSIS) and the various technical publications and reports published by ADFG.

Fish

Fisheries management on state lands and waters is accomplished by the ADFG, Division of Commercial Fisheries and the Division of Sport Fisheries. Since the late 1990s, a summary annual report has been prepared that focuses on subsistence and personal use finfish and other fisheries (Fall et al., 2001a, 2001b; Fall et al., 2002; Fall et al., 2003a,b; Fall et al., 2004; Fall, George, and Easley 2005; Fall, 2006; Fall et al., 2007a,b; Fall and Koster, 2008; Fall et al., 2009a,b; Fall and Koster, 2010; Fall et al., 2011 Fall and Koster, 2012; Fall et al., 2013; Fall and Koster, 2014). These reports summarize subsistence fisheries harvest data from all management areas and sources. Area summaries include background information, regulations, harvest assessment program information, salmon and non-salmon and other fisheries harvests for the survey year, and special information on subdistrict or unique fisheries, such as the Upper Yentna River Fish Wheel Fishery. The resulting Alaska Subsistence Fisheries Database allows for monitoring long-term harvest patterns and trends.

In Federal lands and waters, the Federal land managing agency has responsibility for management. Cooperative agreements among management agencies and stakeholders exist for many regions, and species. USFWS, Office of Subsistence Management (OSM) provides funding for research and publication of biological and subsistence harvest data. USFWS, OSM fisheries and wildlife reports are available online. The NPFMC manages subsistence halibut fishing in Federal offshore waters.

NMFS adopted rules governing subsistence halibut fishing in 2003. A voluntary survey instrument is mailed to all holders of Subsistence Halibut Registration Certificates (SHARCs). In 2012, 71% responded (7,094 of 9,944 surveyed SHARC holders). Area 3B (southcentral Alaska) subsistence halibut fishers harvested some 37% (253,516 lb) of the total estimated harvest of 37,093 halibut (686,991 lb net weight) statewide (Fall and Koster, 2014). (See (Fall et al., 2004) for results for 2003; (Fall, George, and Easley, 2005) for results for 2004; (Fall et al., 2006) for results for 2005; (Fall et al., 2007a,b) for results for 2006; (Fall and Koster, 2008) for results for 2007; (Fall and Koster, 2010) for results for 2008; (Fall and Koster, 2011) for results for 2009; (Fall and Koster, 2012) for results for 2010; (Fall et al., 2013) for results for 2011; and (Fall and Koster 2014) for results for 2012, the most recent year for which summary data are available.) No surveys were conducted in 2013 due to budgetary restraints.

Research programs may focus on particular regions, species, or fisheries management areas. For example, the CMA has been the focus of investigations by ADFG researchers for over 25 years (see Section 3.3.3.4 Southern Alaska Peninsula) and Hutchinson-Scarbrough and Fall (1996); Hutchinson-Scarborough et al. (2010)). Subsistence issues in the Cook Inlet-Kenai Peninsula area have been particularly thorny, in terms of defining rural and non-rural areas, and subsistence and non-subsistence areas, assessing customary and traditional uses, and determining amounts reasonably necessary for subsistence harvests. (See Fall (1983); Fall et al. (2000); Seitz, Tomrdle, and Fall (1992) and sources provided here for subsections titled Tyonek, Beluga, Nanwalek, Port Graham, and Seldovia in Section 3.3.3.4 for more information.).

Birds

Subsistence hunting of migratory waterfowl is managed by the USFWS. Federal regulations limit participation to residents of designated rural areas. In 1997, Congress ratified an amendment to the 1918 Migratory Bird Treaty Act between the U.S., Canada, and Mexico, recognizing traditional spring and summer subsistence bird harvests by northern indigenous peoples. The Alaska Migratory Bird Co-Management Council (AMBCC) was formed in 2000 with representatives from USFWS, ADFG, and regional Alaska Native organizations. Harvest data are collected through the AMBCC's Harvest Assessment Program. Information obtained by this program is used to evaluate Federal subsistence harvest regulations, to document customary and traditional uses of migratory birds in Alaska, and to plan for the continued harvest and conservation of migratory birds. Communities are surveyed on a rotating schedule, adjusted annually according to monitoring priorities and funding availability (Naves and Braem, 2014).

Earlier surveys were conducted by USFWS, playing an important role in refining survey methods and engaging rural subsistence harvesters in the harvest assessment process (Copp, 1985; Copp and Roy, 1986; Wentworth, 2007a, 2007b). The AMBCC survey has been conducted annually since 2004. For harvest information for 2004 through 2007, for information from 2007, see Naves (2010a); for 2008, see Naves (2010b); for 2009, see Naves (2011); for 2010, see Naves (2012); for 2011, see Naves (2014a); for 2012, see Naves and Braem (2014).

Non-Migratory Birds and Small Game

Alaska has three species of ptarmigan and four species of grouse. These are managed by ADFG along with Alaskan hares (*Lepus othus*) and snowshoe hares (*L. americanus*) as small game. ADFG's Division of Subsistence harvest surveys collect data on these species. Small game including these birds and hares typically accounts for <5% of total subsistence harvests by edible weight. The ADFG DWC uses mail-out hunter surveys to understand harvests, location, and hunter effort (Merizon, Carson, and Honig, 2015).

3.3.3.7.1. Other Wild Resources

Plants, berries, wood, firewood, driftwood, coal, and other naturally occurring wild resources are harvested for food, as raw materials for construction and handicrafts, and for fuel. During comprehensive subsistence harvest surveys, respondents are asked about their harvest, use, preparation, and sharing of these resources. Kari (1995) and Russell (2011) report on the general use of plants by Dena'ina and Alutiiq peoples, respectively. Veltre et al. (2006) describe the ethnobotany of Aleut/Unangax peoples on the Aleutian Islands; Garibaldi (1999) compiled the medicinal uses of flora by Alaska Natives from published sources. Wheeler and Alix (2004) report on the economic and cultural importance of driftwood in southwestern Alaska.

3.3.4. Sociocultural Systems

3.3.4.1. Community Populations and Characteristics

Table 3.3.4-1 shows communities and their populations in southcentral Alaska that could be affected by the Proposed Action. This list of places differs from that used in the Subsistence Harvest Patterns section. The communities and places listed in the table reasonably represent the area that could be affected by the Proposed Action. Table 3.3.4-2 presents a general typology for integrating demographic, economic, and sociocultural characteristics of places in the area. Generally, the following terms apply:

- "Cities" exhibit relatively large populations and grow primarily through in-migration of residents, have mostly a wage-market sector economy, and a non-Native culture; that is, a low salience for extended kinship and tribal organization.
- "Towns" exhibit the dominant demographic, economic, and sociocultural characteristics of cities but have sizeable and important commercial-fishing and subsistence orientation and Alaska Native cultural practices. Very often, towns are residential areas that have commercial, cultural, and social connections to nearby cities in the region.
- "Villages" have small populations and little growth through immigration, a dominant commercial fishing and subsistence orientation, and are defined by Alaska Native cultural practices and kinship ties.

Table 3.3.4-1. 2010 Population Count by Community.

Community	Population 2010	Population 2000	Change in Number	% Change
Municipality of Anchorage				
Anchorage	291,826	260,283	31,543	12.12
Eastern Cook Inlet				
Anchor Point	1,930	1,845	85	4.61
Clam Gulch	176	173	3	1.73
Happy Valley	593	489	104	21.27
Homer	5,003	3,946	1,057	26.79
Hope	192	137	55	40.14
Kachemak	472	431	41	9.51
Kasilof	549	471	78	18.10
Kenai	7,112	6,942	170	2.4
Nanwalek	254	177	77	43.50
Nikiski	4,493	4,327	166	3.84
Nikolaevsk	318	345	-27	-7.83
Ninilchik	883	772	111	14.38
Port Graham	177	171	6	3.51
Seldovia City	255	286	-31	-10.84
Seldovia Village	165	134	31	18.78
Soldotna	4,163	3,759	404	10.75
Sterling	5,617	4,705	912	19.38

Community	Population 2010	Population 2000	Change in Number	% Change
Kenai Peninsula Borough	55,400	49,691	5,709	11.4
Western Cook Inlet				
Beluga	20	32	-12	-37.5
Tyonek	171	193	-22	-11.4
Kodiak Island Communities				
Akhiok	71	80	-9	-11.25
Karluk	37	27	10	37.04
Kodiak	6,130	6,334	-204	-3.22
Larsen Bay	87	115	-28	-24.35
Old Harbor	218	237	-19	-8.02
Ouzinkie	161	225	-64	-28.44
Port Lions	194	256	-62	-24.22
Kodiak Island Borough	13,592	13,913	321	-2.3
Upper Alaska Peninsula				
Chignik Bay	91	79	12	15.19
Chignik Lagoon	78	103	-25	-24.27
Chignik Lake	73	145	-72	-49.66
Ivanof Bay	7	22	-15	-68.18
Perryville	113	107	6	5.61

Modified from: U.S. Census Bureau (2015); MMS 2003-055, Vol. III: Table III.C-9 (USDOI, MMS, 2003).

Table 3.3.4-2. Community Types by Demographic, Economic, and Sociocultural Characteristics.

Characteristics	Villages	Towns	Cities
Communities	**Chignik Bay, Chignik Lagoon, Chignik Lake, Ivanof Bay, Karluk, Larsen Bay, Nanwalek, Old Harbor, Ouzinkie, Perryville, Port Graham, Seldovia Village, Port Lions, Ahkiok, Tyonek**	**Ninilchik, Nikolaevsk and Seldovia City (Kenai Peninsula), City of Kodiak (including Chiniak and Womens Bay))**	**Municipality of Anchorage (including Chugach, Eagle River, Eklutna, Girdwood) Kenai-Soldotna Area (including Nikiski, Sterling, Kasilof, Clam Gulch, Happy Valley), Homer (including Anchor Point and Kachemak)**
Demographic Characteristics			
Population Size	Low	Mid-Large	Mid-Large
Growth through in-migration	Low	High	High
Length of Residency	Long-term	Short to Long-term	Short to Long-term
Economic System Characteristics			
Wage Market Sector Development	Low	Moderate	High
Commercial Fisheries Development	Low-High	High	Low
Subsistence Sector Development	High	Moderate	Low
Wild Food Production (per capita)	High	Moderate	Low
Wild Food Distribution	High	Moderate	Low
Domestic Mode of Production	High	Moderate	Low
Sociocultural Characteristics			
Predominant Cultural Group	Native	Non-Native	Non-Native
Significant Native Population	Yes	Yes	No
Extended Kinship-Tribal Organization	High	Moderate	Low

Modified from: Fall et al. (2001a); MMS 2003-055, Vol. III: Table III.C-10 (USDOI, MMS, 2003).

3.3.4.2. Characteristics of the Population

This discussion covers population changes over the last decade (2000-2010), the ethnic composition of the population in 2010, and selected household and family characteristics of the 2010 population. It is noteworthy to compare the changes between 2000 and 2010 with the changes between 1990 and 2000 described in USDOI, MMS (2003).

Population Changes

Table 3.3.4-1 shows the 2000 and 2010 decennial census population counts, in addition to the population increase or decrease for the decade, for selected cities and CDP-named areas within southcentral Alaska. Population data are organized among the following geographic areas: Municipality of Anchorage, Cook Inlet East, Cook Inlet West, Kodiak Island, (which includes all islands within the Kodiak Archipelago), and upper Alaska Peninsula (referred to as the Chigniks). While many communities in the area experienced double- or triple-digit population increases in the decade, others experienced double-digit population reductions. The Municipality of Anchorage grew by 31,543 people, an increase of 12.12%. The community of Tyonek experienced an 11.4% decrease in population, while between 1990 and 2000, it experienced a 25.3% increase in population. On the central Kenai Peninsula, Clam Gulch, Cohoe, Kasilof, Nikiski, and Sterling had single digit to double-digit increases in population between 2000 and 2010. These same communities experienced substantial population increases between 1990 and 2000. The incorporated communities of Kenai and Soldotna had <10% population growth between 1990 and 2010; while Soldotna grew by nearly 11% between 2000 and 2010, and Kenai experienced only 2.4% growth in that same period.

Most southern Kenai Peninsula communities grew during the period. Homer grew by 27%, while Anchor Point's doubling between 1990 and 2000 was not repeated, growing only by 4.6%. Sterling had the second-largest population increase, followed closely by Soldotna, Nikiski, and Happy Valley. The three communities of Tyonek, Nikolaevski, and Seldovia had population declines. The Kenai Peninsula Borough population increased by 11.4% overall between 2000 and 2010.

The pattern of population change on Kodiak Island differs from that of the Kenai Peninsula. The City of Kodiak's population declined slightly. Other communities, such as Old Harbor, Larsen Bay, Ouzinkie, and Port Lions experienced much greater population decreases. Only Karluk's population increased, by 10 people, but the percentage change is 37%. The Kodiak Island Borough's population decreased by 2.3% overall between 2000 and 2010.

On the upper Alaska Peninsula, the Chigniks recorded a mix of population change over the 2000-2010 decade. Chignik Bay gained 12 people (15.2%) whereas between 1990 and 2000 it lost more than half its population. Chignik Lagoon, Chignik Lake, and Ivanof Bay all experienced population decreases. Ivanof Bay's population declined by two-thirds; today (2015) it is considered abandoned. Perryville's population increased by a modest 6 people (5.61%).

Ethnic Composition of the Population

Table 3.3.4-3 shows a selected representation of the ethnic composition of the 2010 population within the area that could be affected by the Proposed Action, identifying the Alaska Native, Asian-American, and "two or more" ethnic group populations that exist among the predominantly Caucasian majority. Some of the smaller communities ("villages" in the typology) have predominantly Alaska Native populations, such as Tyonek in the upper Cook Inlet area, and Nanwalek and Port Graham on the southern Kenai Peninsula. On Kodiak Island, the Asian-American population exceeds the Alaskan Native population. All of the non-road-connected communities on Kodiak Island, including Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions, are predominantly composed of Alaskan Native residents. On the southern Alaska Peninsula, the communities of Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville are predominantly Alaska Native communities, whereas Chignik Bay is more diverse. These characteristics have not changed between 1990 and 2010.

Table 3.3.4-3. Ethnic Composition of the 2010 Population Count and Percentage of Total Count by Community

Community	White		Alaska Native		Asian		Other		Two or More	
	Number	%	Number	%	Number	%	Number	%	Number	%
Municipality of Anchorage										
Anchorage	192,498	65.96	23,130	7.92	23,580	8.08	28,973	9.93	23,645	8.10
Eastern Cook Inlet										
Anchor Point	1,741	90.21	73	3.78	18	0.93	13	0.67	85	4.40
Clam Gulch	150	85.23	10	5.68	0	0.00	2	1.14	14	7.95
Happy Valley	519	87.52	35	5.90	2	0.34	4	0.67	33	5.56
Homer	4,470	89.35	206	4.12	48	0.96	54	1.08	225	4.50
Hope	169	88.02	8	4.17	1	0.52	1	0.52	13	6.77
Kachemak	433	91.74	19	4.02	6	1.27	1	0.21	13	2.75
Kasilof	482	87.80	23	4.19	3	0.55	7	1.28	34	6.19
Nanwalek	27	10.63	204	80.31	0	0.00	0	0.00	23	9.06
Nikiski	3,847	85.62	347	7.72	50	1.11	43	0.96	206	4.58
Nikolaevsk	294	92.45	11	3.46	1	0.31	1	0.31	11	3.46
Ninilchik	690	78.14	136	15.40	3	0.34	7	0.79	47	5.32
Port Graham	15	8.47	126	71.19	0	0.00	2	1.13	34	19.21
Seldovia City	185	72.55	35	13.72	3	1.18	3	1.18	29	11.37
Seldovia Village	96	58.18	43	26.06	1	0.61	2	1.21	23	13.94
Soldotna	3,574	85.85	181	4.35	66	1.58	58	1.39	284	6.82
Sterling	5,044	89.80	246	4.38	44	0.78	39	0.69	244	4.34
Cook Inlet, West										
Beluga	18	90.00	2	10.00	0	0.00	0	0.00	0	0.00
Tyonek	9	5.26	151	88.30	0	0.00	0	0.00	11	6.43
Kodiak Island										
Akhiok	6	8.45	36	50.70	1	1.41	1	1.41	27	38.03
Karluk	2	5.40	35	94.59	0	0.00	0	0.00	0	0.00
Kodiak City	2,469	40.28	607	9.90	2,294	37.42	373	6.08	387	6.31
Larsen Bay	21	24.14	62	71.26	0	0.00	0	0.00	4	4.60
Old Harbor	24	11.01	191	87.61	0	0.00	0	0.00	3	1.38
Ouzinkie	17	10.56	128	79.50	1	0.62	0	0.00	15	9.32
Port Lions	70	36.08	114	58.76	5	2.58	0	0.00	5	2.58
Alaska Peninsula										
Chignik Bay	31	34.06	52	57.14	3	3.30	0	0.00	4	4.40
Chignik Lagoon	16	20.51	49	62.82	1	1.28	3	3.85	9	11.54
Chignik Lake	2	2.74	69	94.52	0	0.00	0	0.00	2	2.74
Ivanof Bay	0	0.00	7	100.00	0	0.00	0	0.00	0	0.00
Perryville	3	2.65	108	95.58	0	0.00	0	0.00	2	1.77

Modified from: USCB (2011); MMS 2003-055, Vol. III: Table III.C-11 (USDOI, MMS, 2003).

Table 3.3.4-4 shows selected characteristics of the year 2010 population in the area, including the number of households per community, the average number of persons per household, and the median age of residents in the community. In 2000, among the communities with populations of >1,000 residents, the City of Homer had both the lowest average number of persons and the highest median age per household. An influx of an older population to Homer has raised the median age. The City of Kodiak had the highest average number of persons per household in 2000, but Nanwalek, Ahkiok, and Karluk now have larger household sizes than Kodiak. Karluk registered the lowest median age. Among the other communities of the upper Cook Inlet and central Kenai Peninsula, median age ranged from 34 in Tyonek (up from 28.3 in 2000) to 52 in Clam Gulch, Happy Valley, and Ninilchik. The average number of persons per household ranges between 2 and 5 throughout the study area.

Table 3.3.4-4. 2010 Population Count Selected Characteristics of the Population

Community	Number of Households	Average Number Persons per Household	Median Age
Municipality of Anchorage			
Anchorage	107,332	3	33
Eastern Cook Inlet			
Anchor Point	840	3	48
Clam Gulch	91	2	52
Happy Valley	270	3	52
Homer	2,235	3	44
Hope	97	2	55
Kachemak	235	2	55
Kasilof	232	3	45
Nanwalek	55	5	21
Nikiski	1,689	3	40
Nikolaevsk	107	3	32
Ninilchik	412	3	52
Port Graham	79	3	31
Seldovia City	121	3	49
Seldovia Village	74	3	49
Soldotna	1,720	3	37
Sterling	2,254	3	45
Western Cook Inlet			
Beluga	10	2	56
Tyonek	70	3	34
Kodiak Island			
Akhiok	19	4	23
Karluk	12	4	19
Kodiak	2,039	3	36
Larsen Bay	34	3	44
Old Harbor	84	3	35
Ouzinkie	56	3	37
Port Lions	77	3	45
Alaska Peninsula			
Chignik Bay	41	3	46
Chignik Lagoon	29	3	36
Chignik Lake	27	3	33
Ivanof Bay	2	4	58
Perryville	38	3	28

Modified from: MMS 2003-055, Vol. III: Table III.C-12 (USDOI, MMS, 2003).

In the southern part of the Kenai Peninsula, the lowest median age in 2010 was in Nanwalek (21) and Port Graham (31), whereas the highest median age was in Kachemak (55). The lowest numbers of persons per household were found in Kachemak, while the highest were in Nanwalek. The predominantly Alaskan Native communities of Nanwalek and Port Graham demonstrated the same characteristics as in 2000, with Nanwalek having a younger population and a larger number of persons per household than Port Graham.

Among the small, non-road-connected communities on Kodiak Island and on the Alaska Peninsula, the highest numbers of persons per household in 2000 were found in Akhiok, and Karluk. All of the other communities had similar numbers of persons per household. Karluk recorded the lowest median age (19), whereas Chignik Bay, Larsen Bay, and Port Lions recorded the highest (46, 44, and 45, respectively).

3.3.4.3. Social Characteristics of the Communities

As indicated in Table 3.3.4-2, the communities within the area that could be affected by the Proposed Action are grouped for discussion purposes into the major population and commercial-industrial centers, the nearby towns that have links to the centers, and the smaller, non-road-connected communities or "villages" in the upper Cook Inlet and Kenai Peninsula area, and the Kodiak Island and Alaska Peninsula area.

Kenai Peninsula Communities

Fishing, tourism, oil and gas, and government sectors undergird the Kenai Peninsula's diversified economic, social, and commercial activities (Alaska Salmon Alliance, 2015; Kenai Peninsula Economic Development District, 2015). Sociocultural systems of these large coastal communities are supported by a diversified economic base with sizeable growth through in-migration (Tables 3.3.4-1 and 3.3.4-2). Much of the population growth over the last 30 years has occurred in associated areas or communities near the cities (Table 3.3.4-1). For example, while the City of Kenai experienced a modest population increase, the associated residential areas experienced much larger growth. Residents from smaller communities must travel to the larger communities for many goods and services such as medical, motor vehicle sales and service, household food and goods, dining and entertainment, air transportation, and government agencies (Federal, state, and borough). Services for the residents of the central Kenai Peninsula area center on the cities of Kenai, Soldotna, Nikiski, and the nearby residential areas such as Sterling, Ridgeway, Salamatof, and Kasilof (Table 3.3.4-5). For residents of the southern Kenai Peninsula, the City of Homer serves a similar function but on a smaller scale. This area encompasses the City of Homer, and the residential areas of Fritz Creek, Anchor Point, Nikolaevski, and Kachemak.

Table 3.3.4-5. Community Description - Cook Inlet Area, Alaska

Community	Culture/Economy
Municipality of Anchorage	
Anchorage	Anchorage is a non-Native community. The majority of the population is non-Native. Many residents participate in recreational and subsistence fishing and hunting. The Anchorage economy provides a variety of employment opportunities to residents. Six-hundred and thirty-eight residents hold commercial fishing permits. The estimated gross fishing earnings of residents exceeds $46 million. Eklutna within the Municipality is a traditional Dena'ina village.
Eastern Cook Inlet	
Anchor Point	Anchor Point is a non-Native community. The majority of the population is non-Native. Many residents work in Homer in a variety of occupations. The community caters to the sport-fishing industry, and several lodges provide services. A small sawmill helps to process timber from various Kenai Peninsula Borough sites. Fifty-three residents hold commercial fishing permits. The estimated gross fishing earnings of residents is approximately $4 million.
Clam Gulch	Clam Gulch is a non-Native community. The majority of the population is non-Native. The Kenai area economy provides a variety of employment opportunities to residents. Thirty-three residents hold commercial fishing permits. The estimated gross fishing earnings of residents is approximately $1.36 million.
Happy Valley	Happy Valley is a non-Native community. The majority of the population is non-Native. The Kenai area economy provides a variety of employment opportunities to residents. Residents rely on Homer, Anchor Point, and Ninilchik for supplies and services. No residents hold commercial fishing permits.
Homer	Homer is a non-Native community. The majority of the population is non-Native. The economy is primarily reliant on fishing, trade, services, and tourism. Approximately 16 cruise ships dock in Homer each summer. Five-hundred and eighty-two residents hold commercial fishing permits. The estimated gross fishing earnings of residents is approximately $83 million. A sawmill processes timber, and wood chips are exported from Homer to Japan.
Hope	Hope is a non-Native community. The majority of the population is non-Native. Subsistence activities are a large part of the local economy.
Kachemak	Kachemak is a non-Native community. The majority of the population is non-Native. Subsistence activities are a large part of the local economy. The Homer economy provides a variety of employment opportunities to residents. No residents hold commercial fishing permits.
Kasilof	Kasilof is a non-Native community. The majority of the population is non-Native. There are two seafood processors in Kasilof, supplying the local community with employment opportunities. The Kenai area economy provides a variety of employment opportunities to residents. One-hundred and twenty-six residents hold commercial fishing permits. The estimated gross fishing earnings of residents is approximately $6 million.

Community	Culture/Economy
Nanwalek	Nanwalek is a traditional Alutiiq (Sugpiaq) village. The majority of the population is Native. Subsistence activities are an integral part of the local culture. The school, subsistence activities, and summer employment at the Port Graham cannery provide a variety of employment opportunities to residents. Six residents hold commercial fishing permits.
Nikiski	Nikiski is a non-Native community. The majority of the population is non-Native. Nikiski is the site of the Tesoro Alaska oil refinery, where Cook Inlet and some North Slope crude oil is processed into jet fuel, gasoline, and diesel. The Agrium, Inc. fertilizer plant closed in 2008 displacing 500 employees. Timber, commercial and sport fishing, government, retail businesses, and tourism-related services provide employment. Thirty-seven residents hold commercial fishing permits. The estimated gross fishing earnings of residents is approximately $1 million.
Nikolaevsk	Nikolaevsk is a non-native community. The majority of the population is non-Native. The community includes Russian Orthodox, Russian Old Believers (Old Right Believers) and some non-Russians, living in three distinct settlements. The Old Believers in this area lead a family oriented, self-sufficient lifestyle. They use modern utilities, and food sources are from gardening, raising small livestock, fishing and hunting. Families are typically very large (8 to 12 children). Traditional clothing is worn. Russian is the first language. Boys typically marry at age 15 or 16, while girls are married at 13 or 14. Many residents are employed in the Anchor Point and Homer areas, primarily in fishing and construction. Twenty-four residents hold commercial fishing permits. The estimated gross fishing earnings of residents is approximately $1.8 million. Boat building also occurs.
Ninilchik	Ninilchik is a traditional Dena'ina Athabascan village. The majority of the population is non-Native. There is a strong Russian Orthodox following, and an historical Church is located in Ninilchik. Subsistence activities, commercial fishing, some tourism, and timber harvests from Native lands occur in Ninilchik. There are two seafood processing plants in Ninilchik, supplying the local community with employment opportunities. The Kenai area economy provides a variety of employment opportunities to residents. Forty-three residents hold commercial fishing permits. The estimated gross fishing earnings of residents is near $2 million.
Port Graham	Port Graham is a traditional Alutiiq (Sugpiaq) village. The majority of the population is Native. Subsistence activities are a large part of the local culture. A fish cannery and hatchery opened in 1999. The cannery provides seasonal employment for 70 Port Graham and Nanwalek residents. Red salmon fry are raised for area lakes, and pink salmon are raised for the cannery. Five residents hold commercial fishing permits. The estimated gross fishing earnings of residents is approximately $130 thousand.
Seldovia City	Seldovia is a non-Native community. It is classified as a First Class City. The majority of the population is non-Native. Commercial fishing and subsistence are an integral part of the local economy. Seldovia is a commercial fishing and processing center. Timber operations at Jakolof Bay and Seldovia Bay have affected the community economy. Tourism is increasing. Forty residents hold commercial fishing permits. The estimated gross fishing earnings of residents are over $2.7 million.
Seldovia Village	Seldovia Village is a traditional Native village. Approximately three-quarters of the population are Alaska Native peoples. Subsistence activities are an important part of the local culture and economy. No residents hold commercial fishing permits.
Soldotna	Soldotna is a non-Native community. It is classified as a First Class City. The majority of the population is non-Native. The Kenai area economy provides a variety of employment opportunities to residents. Soldotna is the site of the Central Peninsula General Hospital, the Kenai Peninsula Community College, the State Troopers' headquarters, the Kenai National Wildlife Refuge, and the borough and school district offices. One-hundred and thirty-nine residents hold commercial fishing permits. The estimated gross fishing earnings of residents are over $6.6 million.
Sterling	Sterling is a non-Native community. The majority of the population is non-Native. The Kenai area economy provides a variety of employment opportunities to residents. The community caters to the sport-fishing industry and summer influx of recreational enthusiasts. Twenty-one residents hold commercial fishing permits. The estimated gross fishing earnings of residents exceeds $2.2 million.
Voznesenka	Voznesenka is a non-Native Old Believer Community. Subsistence is an integral part of the local economy. The Kenai area economy provides a variety of employment opportunities to residents. Many residents hold commercial fishing permits.
Western Cook Inlet	
Beluga	Beluga is a non-Native community. The majority of the population is non-Native. Subsistence activities are integral to the local economy. No residents hold commercial fishing permits.
Tyonek	Tyonek is a traditional Dena'ina Athabascan village. The majority of the population is Native. Subsistence activities are integral to the local economy and culture. Recreational fishing and guiding hunts are new economic activities. Sixteen residents hold commercial fishing permits. The estimated gross fishing earnings of residents is near $69 thousand.
Kodiak Island	
Akhiok	Akhiok is a traditional Alutiiq village. More than half of the population is Native. Subsistence activities are an integral part of both the local economy and culture. Public sector employment and seasonal work provide cash flow in the community. Five residents hold commercial fishing permits. The estimated gross fishing earnings of residents is near $400 thousand.

Community	Culture/Economy
Karluk	Karluk is a traditional Alutiiq village. The majority of the population is Native. Subsistence activities are an integral part of both the local economy and culture. No residents hold commercial fishing permits. Fish processing is the primary source of livelihood. The village corporation shares ownership of a cannery with the corporations of Larsen Bay and Old Harbor, but operations have remained idle in recent years.
City of Kodiak	Kodiak is a non-Native community. The majority of the population is non-Native, and the majority of the native population is Alutiiq. The Filipino population is a large subculture in Kodiak. The local culture is focused on commercial and subsistence fishing activities. The USCG comprises a significant portion of the community, and there is a large seasonal population. A Russian Orthodox church seminary is based in Kodiak, one of two existing seminaries in the U.S. The Shoonaq' Tribe of Kodiak was federally recognized in January 2001. Kodiak College, a branch of the University of Alaska, is located in the City of Kodiak. There are 12 fish processors located in Kodiak. Five-hundred and thirty-one residents hold commercial fishing permits. The estimated gross fishing earnings of residents exceeds $130 million.
Larsen Bay	Larsen Bay is a traditional Alutiiq village. The majority of the population is Native. Subsistence activities are integral to the local economy. The economy of Larsen Bay is primarily based on fishing. There are very few year-round employment opportunities. Six lodges host visitors and provide a tourist guide service. Thirteen residents hold commercial fishing permits. The estimated gross fishing earnings of residents is near $680 thousand.
Old Harbor	Old Harbor is a traditional Alutiiq village. The majority of the population is Native. Subsistence activities are an integral part of the local economy and culture. Residents of Kaguyak, a summer fish camp, also live in Old Harbor. Twenty residents hold commercial fishing permits. The estimated gross fishing earnings exceed $3 million.
Ouzinkie	Ouzinkie is a traditional Alutiiq village. The majority of the population is Native. Subsistence activities are integral to the local economy and culture. The economic base is primarily commercial fishing. Seventeen residents hold commercial fishing permits. The estimated gross fishing earnings exceed $1.1 million.
Port Lions	Port Lions is a traditional Alutiiq village. The majority of the population is Native. Subsistence activities are integral to the local economy and culture. The economy of Port Lions is based primarily on commercial fishing, fish processing, and tourism. Eighteen residents hold commercial fishing permits. The estimated gross fishing earnings exceed $2.2 million.
Upper Alaska Peninsula	
Chignik Bay	Chignik Bay is a Native village located in a historically Kaniagmuit area with Russian and Scandinavian influences. Approximately half of the population consists of Alaska Native peoples. Subsistence activities are an integral part of both the local economy and culture. One seafood processing plant operates in Chignik, supplying the local community with employment opportunities. Ten residents hold commercial fishing permits. The estimated gross fishing earnings exceed $2.2 million.
Chignik Lagoon	Chignik Lagoon is a traditional Koniag village. Over half of the population is Native. Subsistence activities are integral to both the local economy and culture. The village experiences an influx of fishers during the summer months. The population swells by 200 during the fishing season. Twenty-two residents hold commercial-fishing permits. The estimated gross fishing earnings exceed $11.5 million.
Chignik Lake	Chignik Lake is a traditional Alutiiq village. The majority of the population is Native. Subsistence activities are integral to the local economy and culture. Many residents leave the community during summer months to fish from Chignik Lagoon or work at the fish processors at Chignik. Four residents hold commercial fishing permits.
Ivanof Bay	Ivanof Bay is a Native village with traditional Unangan influences. The entire population is Native. Subsistence activities are integral to both the local economy and culture. In summer, most residents leave the community to live and fish near Chignik. No residents hold commercial fishing permits.
Perryville	Perryville is a Native village with traditional Unangan influences. The majority of the population is Native. Subsistence activities are integral to both the local economy and culture. During the summer, the majority of residents leave Perryville to fish in Chignik or Chignik Lagoon. Only a few year-round jobs are available. Commercial fishing provides cash income. Eight residents hold commercial fishing permits. The estimated gross fishing earnings is near $2.5 million.

Modified from: Alaska Department of Commerce, Community, and Economic Development (2015); MMS 2003-055, Vol. III: Table III.C-13 (USDOI, MMS, 2003).

Kenai-Soldotna Area

The social fabric and economy of the Kenai-Soldotna area have been shaped since the late 1950s predominantly by the discovery and development of oil and gas resources nearby on the Kenai Peninsula and in Cook Inlet. The local petroleum industry spawned associated industries such as refining and chemical manufacturing. It also provided important services to North Slope oil fields. As a consequence, a significant number of the peninsula's residents commute from the Kenai to North Slope oil fields (AOGCC, 2009). Construction of modules for the Alpine oil field represented an important new petroleum activity for the area in the 1990s. Additional oil and gas exploration and development work in Cook Inlet provides additional employment. The mature petroleum industry remains an important part of the economy and may continue as the single largest source of well-paying, non-seasonal jobs in the area. Recent job losses reflect the completion of the Alpine module construction project in 2000, and the closure of the Agrium fertilizer plant in 2008. New oil finds and gas strikes are leading to a rebound in oil and gas industry activity in Cook Inlet.

Tourism and recreation is a growing sector of the social and economic composition of the communities. Sport fishing is the largest single attraction on the peninsula. The Kenai River, which flows through the area, supports the largest sport fishery in Alaska. Retail establishments, services, construction, and public sector services make important contributions to the diversity of the area (Kenai Peninsula Economic Development District, 2015).

Excluding Anchorage, the areas immediately outside the cities of Kenai and Soldotna have the largest concentration of the Alaska's population. Growth in most of the surrounding areas was considerably greater than that experienced by the cities (Table 3.3.4-1).

Homer Area

The Homer area is more sparsely populated than the Kenai-Soldotna area and is economically dependent on commercial and sport fishing, and tourism. Several residents work elsewhere in the state or have chosen Homer as the place to retire. The area also has a thriving art community. A commercial-fishing fleet of 487 vessels homeported in Homer in 2013, and the port hosts a sizeable sport-charter-boat fleet. Commercial seafood landings in Homer rank 30th in the U.S. by value, and 53rd by volume (per 2010 to 2013 averages) (Alaska Salmon Alliance, 2015). The natural beauty of the area is a major attraction supporting the visitor industry, with the Alaska Maritime NWR headquarters, and numerous outdoor, nature-oriented businesses and services here.

Small, Non-Road-Connected Communities

The small, non-road-connected communities in upper Cook Inlet include Tyonek, Nanwalek, Port Graham, and Seldovia. The communities, with the exception of Seldovia, are classified as "villages" under the typology presented in Table 3.3.4-2. Residents of Tyonek are predominantly Dena'ina Athabascan Indians, whereas residents of Nanwalek and Port Graham are predominantly Alutiiq people (Braund and Behnke, 1980); Seldovia is more heterogeneous than the other communities. As indicated by Tables 3.3.4-2 and 3.3.4-5 the sociocultural systems of these small coastal communities are supported by a limited economic base, with commercial fishing and seafood processing as the primary income-producing occupations. Maintenance of subsistence activities is considered central to the cultural identity and social well-being of the communities of Tyonek, Nanwalek, and Port Graham, and less so in Seldovia; however, Alaska Native residents in Seldovia appreciate the importance of these activities.

In Tyonek, hunting and fishing patterns more closely resemble those of communities such as Nondalton and Dot Lake than those of communities on the nearby Kenai Peninsula. Subsistence activities in Tyonek are characterized by a well-established annual round of hunting, fishing, and gathering activities; the use of a wide range of marine and land resources; and a kinship-based system for the harvest, processing, distribution, and exchange of wild-resource products (Stanek, Holen, and Wassillie, 2007).

In Nanwalek and Port Graham, which are classified as "villages" in the typology presented in Table 3.3.4-2, a considerable network of resource sharing and distribution exists within each community because the communities are closely related by family ties, common hunting and fishing practices, and local customs. Russian Orthodox holidays, name days, and birthdays, among others, are occasions for celebration, and use locally harvested foods, and many daily meals of families in these communities incorporate similar resources. Subsistence- and commercial-fishing activities, in addition to visiting, recreation, and political relationships, are primarily based on the complex web of kinship networks and family relationships in these communities. Residents feel a strong bond to their communities, both to the physical surroundings and to their relatives and friends (Braund and Behnke, 1980).

Seldovia is a multiethnic community that has a character similar to other rural, White, frontier fishing towns. In the typology of places presented in Table 3.3.4-2, Seldovia is classified as a “town” relative to other places in the study area. Seldovia in the early 1900s was a thriving commercial fishing community and the center for commercial and social life for all of Kachemak Bay and Cook Inlet (Reed, 1983). Many Scandinavian and other fishers immigrated to Seldovia and intermarried with the local population. It was not until the 1960s that other commercial centers outgrew Seldovia and diminished its commercial importance. Seldovia today has a sizeable, yet declining, Alaska Native population (see Tables 3.3.4-1 and 3.3.4-3).

Kodiak Island

Table 3.3.4-5 presents a brief overview of the social and economic characteristics of the area’s communities. The City of Kodiak and its surrounding road-connected residential areas provide diversified social, commercial, and other services for residents of Kodiak Island, in addition to an important commercial fishing port. However, in the typology of places presented in Table 3.3.4-2, the City of Kodiak is classified as a “town” relative to other places in the study area. Residential areas outside Kodiak proper include places such as Chiniak, USCG Station Kodiak, and Womens Bay. A similar core area does not exist among the upper Alaska Peninsula communities.

Kodiak City Area

The City of Kodiak is the largest and most culturally diverse community on Kodiak Island, representing different cultural backgrounds and traditions. Kodiak originated in the Russian era and evolved into a commercial-fishing center before the turn of the century. The emphasis on fishing continues to the present, and has been a unifying force in the community. A less seasonal and more dependable year-round economy for the community was established in the late 1940s with diversification into crab and other species. Kodiak’s downtown waterfront district was severely damaged by a tsunami generated by the 1964 earthquake, but the area was almost entirely rebuilt by 1970. Today, Kodiak is the home of the largest commercial-fishing fleet in Alaska (Fall et al., 2001a, 2001b; USDOI, MMS, 1984). While fishing and related processing dominates the economy, the USCG station, tourism, timber, and the nearby Kodiak space launch facility make important contributions to the economy.

Interests and concerns of the fishing industry permeate Kodiak’s entire social fabric. In keeping with fisheries traditions, a relatively large group of resident and transient workers who process the catch are supported onshore. Like the fishing fleet and shore-side workers, other residents of Kodiak also are drawn into the predominantly fisheries way of life, with its danger, intensity, and commitment as well as its recreational, social, and political imperatives. The isolation and relatively small size of the Kodiak area encourage rapid organization and mobilization around key issues affecting the community. Issues that could affect the fisheries way of life have tended to mobilize considerable unity within the community (Fall et al., 2001a, 2001b; Impact Assessment, Inc., 2001; USDOI, MMS, 1984).

Small, Non-Road-Connected Communities

The small, non-road-connected communities of the Kodiak Island and upper Alaska Peninsula area that could be affected by the Proposed Action include Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions on Kodiak Island, and Chignik Bay, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville on the Alaska Peninsula. All of these communities are classified as “villages” under the typology presented in Table 3.3.4-2.

This description is based primarily on the results of an MMS-sponsored study of the small communities on Kodiak Island and the upper Alaska Peninsula (Cultural Dynamics, Ltd., 1986a). All of these communities are physically isolated, yet linked by year-round air transportation to other Alaskan communities and regional centers. In addition to providing a detailed description of the area, the study found:

- Dual residency is an established pattern among the five Alaska Peninsula communities, with people living away from their “home” community for many months of the year when employed, or working in the fishing industry as skippers, crewmembers, or providing shoreside services
- Social and kinship links appear greater between the southern Kodiak Island communities and the Alaska Peninsula, and between Chignik and Kodiak City, than between the southern and northern Kodiak communities; and
- Several traditional family patterns—such as households containing three generations of people—persist, especially in the southern Kodiak communities

The Kodiak/Alaska Peninsula area includes three old communities (Karluk, Akhiok, and Chignik); three relatively new communities (Chignik Lake, Ivanof Bay, and Port Lions) established since 1950; and a shared linguistic and cultural foundation (Mishler, 2001). These Alutiiq people experienced Russian influences, especially in the northern Kodiak Island area, and the rapid expansion of commercial salmon fisheries and canneries in the late nineteenth century, where influences were felt especially strongly in the Karluk, Chignik Bay, and Chignik Lagoon areas from cannery operations located nearby. The Scandinavian influence was greatest in the Chignik and Chignik Lagoon areas. Contact between the upper Alaska Peninsula area and Kodiak Island may have been frequent in the first part of the 20th century, with travel, visiting, and intermarriage occurring during the fur-trading and early commercial-fishing period. Kinship ties through marriage continue to link the Kodiak Island communities with the Pacific Coast side of the peninsula; there are few marriages between residents born on the southern end of Kodiak Island, especially Old Harbor and Akhiok, and northern-end residents. Community migration patterns emerging in the period from 1984 to 1985 indicated a movement of families from a smaller community to the nearest larger community on Kodiak Island — from Karluk to Larsen Bay, from Akhiok to Old Harbor, and from Ouzinkie to Port Lions.

Seasonality of residency in the Kodiak Island and upper Alaska Peninsula communities is based on the rhythms of commercial fishing. This is more marked on the Alaska Peninsula than on Kodiak Island, with Chignik Bay and Chignik Lagoon expanding greatly in June when many residents from the other communities migrate for summer salmon fishing. However, as indicated by Table 3.3.4-1, Larsen Bay, Ahkiok, Old Harbor, Ouzinkie, Chignik Lake, Chignik Lagoon, and Ivanof Bay experienced significant population declines between 2000 and 2010.

Fisheries Orientation

Most of the Kodiak Island and Chignik area communities share a tradition of commercial fishing, but the level of participation varies importantly from one community to another. According to Langdon (Cultural Dynamics, Ltd., 1986b), community groupings were evident in the early 1980s based on participation in commercial fisheries. Chignik Lake, Perryville, and Ivanof Bay fishers were almost totally dependent on traditional salmon fishing with sparse evidence of investment in large boats or participation in winter crab fisheries. These traditional fishers were independent vessel owners, demonstrated greater reliance on kinsmen for crewmembers, and continued to maintain relationships with processors for services. Fishers from Chignik Bay and Chignik Lagoon, on the other hand, showed more diversification, with some venturing into fishing king and Tanner crab in the 1970s. Fishers from these two communities tended to hire more non-relatives and non-local crewmen, although there still was a strong reliance on kinsmen for salmon fishing. Ties with processors were very weak because these fishers bargained independently with local and outside processors (Reedy-Maschner, 2009, 2010).

Prior to 2002, the CMA commercial fishery was managed as a competitive limited entry permit fishery. Between 2002 and 2005, the commercial fishery was managed based on two management plans, the CMA Competitive Fishery Management Plan, and the CMA Cooperative Purse Seine Salmon Management Plan. Since 2006, the CMA commercial fishery has been managed solely as a competitive fishery. Management problems such as the timing of openings and closings, and prohibitions on when commercial fishers could subsistence fish during the cooperative fishery years created community discord between 2002 and 2006. Combined with recent global market instability, and lingering effects from the Exxon Valdez Oil Spill, fishing in the Chigniks is more challenging now than at any time in the past.

A similar pattern of substantial involvement and diversification existed on Kodiak Island among the communities of Old Harbor, Port Lions, and Ouzinkie, although traditional fishers were present (Mishler and Mason, 1996). Of these communities, Port Lions appeared to be the most similar to the City of Kodiak in terms of the size of vessels, the fisheries pursued, and the proportion of total earnings derived from different species. A third community pattern was one of declining involvement in commercial fisheries, a pattern found in Larsen Bay, Akhiok, and Karluk, originally traditional salmon-oriented communities. Fishers from these communities had sold most of their permits, particularly set-gillnet permits, for a variety of reasons, such as poor local harbors, lack of vessel- and gear-storage facilities, natural disasters, and poverty. Although commercial fishing was still important to residents of Larsen Bay, participation was declining as those who could not or would not diversify left the fishery. Residents of Akhiok and Karluk appeared to be only minimally involved in commercial fisheries.

While salmon is nearly always one of the leading fisheries, Kodiak has the most diversified fishery in the state, and the dominant fishery can change in a short time. Island residents also fish in other Alaskan waters. They participate in at least 27 different types of fisheries. More residents live off the fishing industry than anywhere else in Alaska. The commercial salmon fishery continues to attract new participants. Many fishers in Kodiak work in more than one fishery. More fishers have diversified their harvests, because fluctuations in prices and species availability make reliance on a single fishery risky (Carothers, 2012).

3.3.4.4. Institutional Organization of Communities

The communities that could be affected by the Proposed Action are organized institutionally among units of local governments established under state law, by tribal organizations, or by village and regional ANCSA for-profit corporations, regional non-profit Native organizations, and various special-purpose organizations such as the AMBCC, CIMMC, ANHSC, and Cook Inlet Keeper (Fall et al., 2001a, 2001b).

Cook Inlet and Kenai Peninsula

The communities of the Kenai Peninsula are organized under the Kenai Peninsula Borough, a second-class borough incorporated in 1964. The Kenai Peninsula Borough includes most of the Kenai Peninsula and coastal lands on the western side of Cook Inlet. Within the Kenai Peninsula Borough, Seldovia incorporated as a first-class city in 1945, and Kenai incorporated as a home-rule city in 1960. Port Graham and Nanwalek, formerly English Bay, are the two westernmost communities of the Chugach Alaska Corporation. Both communities are served by Chugachmiut, the tribal organization serving the Chugach Native people of Alaska with health and social services, education and training, and technical assistance.

Homer and Soldotna incorporated as first-class cities in the mid-1960s. Kachemak City is a second-class city. Tyonek organized a tribal council for the community under the Indian Reorganization Act in the late 1930s; it remains today as the governing body for the community (Stanek, Holen, and Wassillie, 2007). Regional Native social and health services organizations include the Southcentral Foundation, Cook Inlet Tribal Council, and Chugachmiut (formerly known as the North Pacific Rim). ANCSA corporations include CIRI, Salamatof Native Association, Inc., and Chugach Alaska Corporation. A number of federally recognized tribes on Kenai Peninsula provide a range of programs and services for members and their communities. The Kenaitze Indian Tribe, Ninilchik Traditional Council, Salamatof Tribal Council, and Seldovia Village Tribe administer various health, social service, training, arts and culture, and other programs benefitting members and their communities; Section 3.3.5 presents additional information about institutions and services provided throughout the proposed Lease Sale Area.

Kodiak Island

Kodiak Island communities are incorporated into the Kodiak Island Borough, formed in 1963 as a second-class borough. The borough also includes uninhabited coastal lands opposite the archipelago on Shelikof Strait. The City of Kodiak is a home-rule city, formed in 1940, whereas five of the non-road-connected communities (except Karluk) incorporated as second-class cities in the late 1960s and mid-1970s. Tribal councils exist in these communities. The Karluk Tribal Council was formed in 1939 and is recognized by the State of Alaska as the local government for the community (Cultural Dynamics, Ltd., 1986a). The KANA provides regional tribal services to most of the Native communities. Koniag, Inc. is the regional ANCSA corporation for the communities on Kodiak Island.

Alaska Peninsula

The five communities located in the Chignik area are part of the Lake and Peninsula Borough, formed in 1989 as a home-rule borough. Chignik is the only second-class city, incorporated in 1983. A tribal council exists in Chignik. The other communities are governed by traditional tribal councils. The communities are members of the Bristol Bay Native Corporation (BBNC) and the Bristol Bay Native Association.

3.3.5. Public and Community Health

3.3.5.1. Introduction

This section presents an overview of public health in the areas that comprise the affected environment for this Draft EIS. The affected environment for public health consists of communities located in or near the proposed Lease Sale Area.

The main health conditions that burden the population near the proposed Lease Sale Area are the same ones seen elsewhere in Alaska and the contiguous U.S.: cancer, heart disease, respiratory diseases, overweight/obesity, diabetes, and intentional and unintentional injury (violence and accidents).

Rates of these conditions in the Cook Inlet area parallel those seen elsewhere in Alaska, although the rates of some are higher. These diseases and health conditions arise from a complex combination of factors that affect populations and individuals, including individual behaviors, environmental conditions, institutional supports, and social and economic circumstances.

While health determinates such as diet, income, and employment play a critical role in supporting or undermining the health of individuals and populations, it is important to note that factors relevant for disease generation in the Alaskan population are not necessarily the same as those that apply to populations elsewhere.

3.3.5.2. Data Sources

Primary data sources for this public and community health assessment come from the following recent publications, supplemented with many additional references:

- Community Health Status Assessment February 2014 (MAPP of Southern Kenai Peninsula, Alaska, 2014a)
- Community Health Needs Assessment March 2014 (MAPP of the Southern Kenai Peninsula, Alaska, 2014b)
- Community Profiles for North Pacific Fisheries – Alaska (Himes-Cornell et al., 2013);
- Relationships between Health of Alaska Native Communities and Our Environment. Phase I – 2013 (Smith, 2013)
- BRFSS 2013 (Alaska Department of Health and Social Services (ADHSS), 2014a);
- Alaska Population Overview – 2013 Estimates (ADLWD, 2015b)
- Assessment of Cook Inlet Subsistence Consumption, 2013 (Merrill and Opheim, 2013); and
- Teen Births and Adolescent Sexual Health in Alaska – 2014 (ADHSS, 2014b)

3.3.5.3. Study Area and Population Demographics

The affected environment for this section of the Draft EIS comprises the communities whose residents may be affected by social or environmental changes potentially resulting from the proposed oil and gas offshore exploration activities in the Cook Inlet area (Table 3.3.5-1). Some of these communities lie outside the immediate proposed Lease Sale Area, but residents of these communities use the inlet for many purposes, and therefore these communities have been included in the affected environment for public health. Table 3.3.5.-1 presents the population demographics within communities potentially affected by the Proposed Action.

Table 3.3.5-1. 2010 Southern Kenai Peninsula Population Estimates.

2010 Population Estimates – USCB		% AK Native Population	Median Age (years)
Area	Population		
Anchor Point	1,930	4	47.1
Diamond Ridge	1,156	3	45.6
Fox River	685	0	19.2
Fritz Creek	1,932	3	42.3
Halibut Cove	76	7	47.5
Happy Valley	593	6	51.3
Homer	5,003	4	44.1
Kachemak City	472	4	54.2
Nanwalek	254	80	20.7
Nikoleavsk	318	4	31.3
Ninilchik	883	15	51.8
Port Graham	177	71	30.3
Seldovia	420	26	48.5
Total 13,823+		*	*

Notes: * = Kachemak Selo, Razdolna, and Vosnesenka, which are not tracked individually, but are included in the Fox River community values. (Source: MAPP of the Southern Kenai Peninsula, 2014a,b). USCB = U.S. Census Bureau.)

In 2010, 84.6% of residents in the southern Kenai area identified themselves as White, 11.6% identified themselves as at least part American Indian or Alaska Native, 2.1% identified themselves as at least part Asian, 1.0% identified themselves as at least part Black or African American, and 0.3% identified themselves as at least part Native Hawaiian or Other Pacific Islander. In addition, 3.0% of residents identified themselves as Hispanic or Latino (Himes-Cornell et al., 2013).

The estimated per capita income for the region was $29,127, and the estimated median household income was $57,454. Of the 42,483 residents aged ≥16, an estimated 64.1% were part of the civilian labor force. Education services, health care, and social assistance sectors employed 22.3% of workers, more than other sectors did; these were followed by agriculture, forestry, fishing, hunting, and mining sectors (cumulatively employing 12.1% of workers), and the retail trade sector (employing 10.3% of workers). Unemployment in 2010 was estimated at 5.5% (Himes-Cornell et al., 2013).

3.3.5.4. Health Indicators

General health indicators can provide a picture of the health status of a population. Health indicators can be compared across time and across different regions to understand how the health of one population compares with the health of others.

Chronic Diseases

In the Kenai Peninsula area, the top 3 causes of death from 2007 to 2011 were: 1) cancer; 2) heart disease; and 3) unintentional injury. In all of Alaska, and all of the U.S., heart disease is responsible for the greatest number of deaths, followed by cancer. The mortality rate from cancer in Alaska is 162 deaths per 100,000. There were 231 deaths due to cancer and 193 deaths due to coronary heart disease and other heart-related deaths in the southern Kenai Peninsula from 2007 to 2011 (MAPP of the Southern Kenai, 2014b).

Infectious Diseases

Infectious diseases disproportionately impact Alaska Natives compared to non-Natives (Holman et al., 2011). The main infectious diseases that are influenced by resource development are sexually transmitted infections (STIs) and infectious respiratory diseases, including tuberculosis (TB). In 2012, Alaska ranked first among the 50 states in TB rates (9 per 100,000 persons) (Centers for Disease Control and Prevention, 2015).

Alaska has had the first or second highest rate of *Chlamydia trachomatis* (CT) in the nation since 2000. The incidence rate of CT in Alaska is 705.2 per 100,000 (MAPP of the Southern Kenai Peninsula, 2014a). Untreated CT infection can cause pre-term labor, pelvic inflammatory disease (PID), ectopic pregnancy, and infertility in women; and epididymitis, and Reiter's Syndrome in men. Additionally, CT can facilitate the transmission and acquisition of human immunodeficiency virus (HIV) (ADHSS, 2014b).

Alaska currently is experiencing a *Neisseria gonorrhea* (also known as gonococci (GC)) epidemic that started in 2008 and peaked in 2010. Untreated or inadequately treated GC infection can result in pre-term labor, PID, ectopic pregnancy, and infertility among women; and epididymitis and infertility among men. Like CT, GC infection increases the likelihood of transmission and acquisition of HIV (ADHSS, 2014c).

Nutrition

Diet and nutrition play an important part in health. Native populations in Alaska as well as in other areas have experienced marked changes in disease patterns stemming from the rapid transition from a healthy subsistence diet, to a less healthy diet and lifestyle akin to those of Western populations. Dietary changes have contributed to drastic increases in obesity, diabetes, and other chronic diseases (Kuhnlein and Receveur, 1996).

People with diabetes have increased risk for heart disease and stroke, in addition to blindness and renal disease, while increased risk of chronic diseases and premature death are faced by people who are overweight (a body mass index (BMI) of 25.0 to less than 30.0, or considered obese (a BMI of 30.0 or greater). Diabetes afflicted 7% of Alaska adults, 36% of Alaska adults were considered overweight, and 30% were considered obese in 2013. While there was no difference by sex in the prevalence of obesity, men were more likely than women to be overweight (ADHSS, 2014a).

Diets of people living in the Kenai Peninsula area include both traditional, or subsistence, foods and non-traditional, or store-bought foods. Traditional diets are associated with numerous health benefits and reduce the risk of many chronic diseases including diabetes, high blood pressure, high cholesterol, heart disease, stroke, arthritis, depression, and some cancers (Adler et al., 1994, 1996; Bjerregaard et al., 2004; Ebbesson et al., 1999; Murphy et al., 1995; Reynolds, Wetzel, and O'Hara, 2006). Traditional or subsistence diets in the Kenai Peninsula area may expose native populations to increased risk of toxic chemical accumulation due to their heavy reliance on fish taken from the Cook Inlet area (Merrill and Opheim, 2013).

The average fish consumption rate among people in tribal communities in the Kenai Peninsula is approximately 5 times greater than the average consumption rate recommended by the EPA, and 15 times greater than the rate used by ADEC in calculating human health parameters based on ambient water quality criteria and standards for toxins. These results suggest that the EPA's and State of Alaska's adopted ambient water quality criteria and standards for toxic pollutants, coupled with the fish consumption rates currently used in those calculations may not be sufficient to protect Alaska Natives residing in the Cook Inlet area (Merrill and Opheim, 2013).

Injuries

Injuries can lead to lost worker productivity and income, increased health care costs over the short and long term, disability, and death. Injuries not only impact those involved; caregivers and family members also can experience mental anguish and decreased quality of life. In Alaska, injuries account for a large proportion of premature death, particularly in children and within Native populations (McAninch, 2012). Unintentional injury ranks third as a leading cause of death in the Kenai Peninsula (MAPP of the Southern Kenai Peninsula, 2014b).

Social Pathologies and Mental Health

Social pathologies are social factors, such as poverty, old age, or crime, which tend to increase social disorganization and inhibit personal adjustment. Social and psychological problems, including alcohol abuse and drug problems, unintentional and intentional injury, suicide, depression, anxiety, and assault and domestic violence, are prevalent in many rural Alaska Native communities. Alcohol abuse is linked to chronic disease, interpersonal violence, injuries, disintegration of family structure and well-being, and adverse home environments for children. In particular, many incidents of interpersonal violence or injury are associated with "binge," or episodic, heavy drinking (defined as 5 or more drinks for men or 4 or more drinks for women on one or more occasions in the past 30 days). The Kenai Peninsula has alarmingly high numbers of individuals engaged in sexual violence, physical violence, or both (Alaska Department of Public Safety, 2012).

The alcohol induced mortality rate in Alaska is 15.3 per 100,000. Nineteen percent of Alaska adults reported binge drinking in 2013 with binge drinking by males (23%) significantly higher than by females (14%) (ADHSS, 2014a). Binge drinking is associated with injury, both intentional and unintentional. In 2011, 26.3% of adults in the southern Kenai Peninsula reported engaging in binge drinking in the past 30 days. In contrast, binge drinking was reported in 20.2% of all Alaskans and 18.3% for the U.S. for the same period. Binge drinking was reported in 41.0% of high school students in the southern Kenai Peninsula compared to 16.5% for Alaska and 21.9% for the U.S. (MAPP of the Southern Kenai Peninsula, 2014a).

Alaska was ranked as one of the top ten states for rates of illicit drug use in a number of categories according to the 2012-2013 National Survey on Drug Use and Health. Alaska was sixth highest in the nation for adult illicit drug use within the past month: 13.3% of adult Alaska residents reported illicit drug use within the past month compared to the national average of 9.28%. Additionally, Alaska ranked 21st nationally for juvenile use of illicit drugs within the past month: 12.07% of Alaska juveniles used illicit drugs in the past month versus the national average of 9.54%. Alcohol, cocaine, heroin, marijuana, methamphetamine, and prescription drugs are primary substances of abuse and focus of most law enforcement efforts in the state (Alaska State Troopers, 2015). There were 34 drug-induced deaths in the southern Kenai Peninsula in 2007-2011 (MAPP of the Southern Kenai Peninsula, 2014a). The Kenai Police Department reported 140 drug related offenses in 2012 (ADHSS, 2012).

Higher mortality from unintentional injuries occurs among Alaska Natives. In 2010, mortality from unintentional injury in Alaska was 58.3 per 100,000 compared to 100.3 per 100,000 for Alaska Natives and 37.9 per 100,000 for the U.S. (MAPP of the Southern Kenai Peninsula, 2014a). There were 33 deaths from unintentional injury in the Kenai Peninsula in 2013 (ADHSS, 2015).

In 2010 the mortality rate from suicide among the population 25 years and older was 25.0 per 100,000 for all Alaskans versus 36.4 per 100,000 for Alaska Natives and 16.4 per 100,000 for the U.S. Higher mortality from suicide occurs in Alaska Natives aged 15 to 24 years. Deaths from suicide were 116.9 per 100,000 in Alaska Natives compared to 46.0 per 100,000 for all Alaskans, and 10.5 per 100,000 for the U.S. (MAPP of the Southern Kenai Peninsula, 2014a).

The Kenai Police Department reported 13 cases of aggravated assault and 70 cases of other assaults in 2012 (Alaska Department of Public Safety, 2012). In 2013, 30.1% of adult women in the Kenai Peninsula Borough experience sexual violence in their lifetime (Morton et al., 2013). In 2011 and historically, child abuse and neglect rates in Alaska (14.1 per 1,000 children) are significantly higher than in the U.S. overall (9.1 per 1,000 children). The data over the past five years does show improvement in the Alaskan and U.S. rates of substantiated child maltreatment, although the Alaskan rate remains more than 50% higher than the U.S. rate (Mohelsky, Fenaughty, and McEwen, 2014).

Birth and Death Rates

Birth and death rates provide insight into health status and social wellbeing at a societal level, since they are highly sensitive to changing social and environmental conditions. Kenai Peninsula Borough births in 2012 to 2013 were reported to be 711, or 1.25% of the end period population. Deaths equaled 368 individuals or 0.65% of the end period population (ADLWD, 2015b).

Population data from the 2010 U.S. Census show that the area has experienced a 10% population increase within the past ten years. Within this same timeframe, the number of 55 to 59 year olds in the Kenai Peninsula Borough has increased by 106% (ADLWD, 2015b). The Kenai Peninsula Borough estimates a continuation of this trend, with the senior population (those aged ≥65) expected to grow 87% between 2008 and 2018. As the population ages, it is likely that healthcare needs, and therefore usage, will increase, resulting in an expected increase of health care usage in the immediate future (MAPP of the Southern Kenai Peninsula, 2014b).

Health Disparities

In Alaska, health inequities generally can be found when examining differences between rural and urban populations, and among racial and socioeconomic groups. Alaska Natives, people living in rural areas, and the poor are generally worse off in terms of almost all measurable health indicators than others in Alaska. In the year 2000, the life expectancy for Alaska Natives was 69.5 years, lagging behind the life expectancy of 76.5 years for the general U.S. population (Parkinson, Orr, and Murphy, 2006). Rates of unintentional injury are higher for Alaska Natives, as is cancer mortality, social pathologies (including suicide, homicide, family and intimate partner violence), smoking-related illness such as lung cancer, and chronic lower respiratory diseases (Day, Provost, and Lanier, 2006, Lanier et al., 2006). Indicators of maternal and child health also are worse for this group.

Public Health and Climate Change

Alaskan communities are particularly vulnerable to the health effects of climate change, and global climate change is increasingly recognized as a determinant of health (Berner and Furgal, 2005).

Changing weather patterns could affect a wide range of health-related outcomes. Climate change may affect both subsistence food availability and storage, and may increase risks associated with subsistence activities, which in turn may lead to dietary and cultural change. Climate change can affect water, sanitation, housing, transportation infrastructure, cultural continuity, community stress levels, the spread of infection, and even the types of diseases and infections to which a population is susceptible (Arctic Climate Impact Assessment, 2004; Brubaker et al., 2010; Brubaker et al., 2011).

3.3.5.5. Heath Care Services

Health care resources play a specific role in prevention of disease and illness, and a widespread role in their treatment. The adequacy of health care resources is dependent on universality of access and availability of resources. Access to specialist care (and some of the allied health professions, such as mental or nutritional health) may be quite limited in rural areas, unless the patient travels to a major population center.

In the Kenai Peninsula, the hub for health care services is Homer (MAPP of the Southern Kenai Peninsula, 2014b). For most Kenai Peninsula communities, access to Homer's health care services is by road with a maximum driving distance of approximately 72 km (45 mi). Transportation to Homer for communities across Kachemak Bay, such as Seldovia, Port Graham, Nanwalek, and Halibut Cove, consists of a one to one and a half hour boat ride, or a 20-minute flight in a small aircraft. Round-trip from Homer to communities across the bay can cost anywhere from $46 to $120. A few organizations provide transportation assistance to clients via shuttle or taxi vouchers, however, there are no public buses, subways, or shuttles available to assist people in getting to services. It is difficult to travel in this area, and additionally, planes, boats, and roads are severely impacted by weather conditions that often leave people stranded away from home for days (MAPP of the Southern Kenai Peninsula, 2014b).

Healthcare services in the area are fairly comprehensive and most needs can be met locally. A 22-bed community-owned critical and acute care hospital is the hub of medical practice in Homer. This hospital offers trauma level IV emergency care seven days a week, as well as acute, surgical, lab, imaging, orthopedic, and primary care (MAPP of the Southern Kenai Peninsula, 2014b).

There is a local family planning clinic and a women's services agency and shelter. Six midwives practice in the community. The local public health clinic employs four public health nurses, who offer regular clinics locally, as well as visiting remote communities. Also located in Homer are the State of Alaska's Office of the Division of Family and Youth Services, Office of Public Assistance, and the Women/Infant/Children Office (MAPP of the Southern Kenai Peninsula, 2014b).

Numerous social services and non-profit agencies, wellness and recreational programs, educational, cultural, and spiritual offerings complete the growing list of services that support the broad definition of health in the community. Service needs for communities remain constant, so it is a challenge for all service providers to maintain a consistent baseline level of care (MAPP of the Southern Kenai Peninsula, 2014b).

Additional health care services in the Kenai Peninsula area include Central Peninsula General Hospital in Soldotna, a privately owned clinic in Anchor Point that provides general and emergency care, and limited emergency medical services provided by the Clam Gulch Volunteer Fire Department (Merrill and Opheim, 2013). Medical services are also available at the Nanwalek Clinic. Alternative health care is provided by Nanwalek First Responders. Emergency services are provided by volunteers and the local health aides using aircraft (Merrill and Opheim, 2013).

3.3.5.6. Summary

Populations in the Kenai Peninsula are experiencing health trends similar to that of the rest of the Alaskan and U.S. populations, but health conditions in the affected area tend to be worse, especially for conditions like diabetes, obesity, respiratory illness, and injury. Health care services play a major role in altering the health conditions of all populations, including those with the unique environmental and cultural characteristics of southern Alaska. A consideration of this local health data and health indicators will allow for recognition of important risks associated with the Proposed Action and the eventual development of effective mitigation strategies.

3.3.6. Recreation and Tourism, and Visual Resources

3.3.6.1. Recreation and Tourism

Recreation and tourism are important areas of economic activity in Cook Inlet and the two are closely linked. Opportunities to participate in outdoor recreation are an essential element in the quality of life for residents of Alaska (Brooks and Haynes, 2001). Furthermore, tourism is one of the driving forces behind Alaska's economy (BLM, 2006), and recreation is the key component of tourism that attracts in-state and out-of-state tourists to Cook Inlet. Expenditures made in the pursuit of both outdoor recreation and tourism contribute to the area's economy.

In 2006 and 2007, the Alaska Residents Statistics Program (ARSP) randomly surveyed Alaska residents by mail to gather information on travel patterns, subsistence and recreational activities, and how public land relates to quality of life (Fix, 2009). Not surprisingly, the Anchorage subregion had the highest visitation rate from each of the other regions in the state (Fix et al., 2009). In addition, residents in southcentral Alaska reported that the primary outdoor recreational or subsistence activities of significance in which they participated were fishing, hiking, camping, and hiking (Fix, 2009). The top reason for fishing and hunting was to obtain meat/food, and the top reason for hiking was exercise and physical fitness. Results of the ARSP's survey also reinforce the idea that opportunities to participate in outdoor recreation are an essential element in the quality of life for Alaskan residents (Fix, 2009).

Alaskans generally participate in two broad categories of outdoor recreation: community-based recreation and "wildland" or resource-based recreation (ADNR, 2009c). Community-based recreation plays an important role in serving daily recreational needs. This type of recreation is often family- or school-oriented. Examples of community-based recreational activities include outdoor court and field sports (e.g., tennis, basketball, softball, soccer), golf, hockey or ice skating, alpine skiing, picnic and playground activities, and trail-related activities, such as bicycling, snowmobiling, cross country skiing, jogging, and walking for fitness. In many of Alaska's primarily Native communities, activities often associated with recreation, such as hunting, trapping, fishing, or berry picking, are also important subsistence activities that are undertaken more for economic or cultural reasons than for recreation (ADNR, 2009c).

Love of the outdoors and resource-based recreation are major parts of the Alaskan lifestyle. Popular wildland recreational activities include fishing, hunting, hiking, skiing, bird watching, snowmobiling, off-road vehicle (ORV) riding, wildlife viewing, recreational mining, mountaineering, whitewater rafting, spelunking, dog mushing, ocean kayaking, and power boating. The rate at which Alaskans participate in wildland recreation is twice that of the rest of the country (ADNR, 2009c).

Recreational activity can bring substantial additional income into local economies, including those around Cook Inlet. Recreational opportunities and environmental amenities are often significant factors in determining tourism (Brooks and Haynes, 2001). Alaska's reputation as wide open and undisturbed is so broadly appealing that people are willing to invest large amounts of time and money to visit Alaska and Cook Inlet. Consequently, the tourism or visitor industry is the only private sector basic industry in Alaska that has grown continuously since statehood (Colt, 2001).

A total of 1,932,600 out-of-state visitors traveled to Alaska between October 2013 and September 2014 (McDowell Group, 2015). Many visitors to Alaska experience the state from a cruise ship, and cruise ships accounted for 50% of out-of-state visitors. Those travelling on cruise ships often visit locations along the way via excursions with guides and outfitters, such as glacier landings. Another 46% traveled to and from Alaska by air. The ANC had almost 2.4 million enplanements during 2014 (FAA, 2015), supporting the conclusion that air travel is the primary means of travel for tourists arriving in the Cook Inlet area. The remaining ≥4% traveled to or from Alaska by highway or ferry. Spending by these visitors supports Alaska's economy and outdoor recreational industry.

Two types of large passenger vessels are active in Cook Inlet: Alaska Marine Highway System (AMHS) ferries, and cruise ships (Cape International, 2012). For example, in 2010, one ferry (with "fill-ins" by a second ferry) operated in Cook Inlet throughout the year, among Homer, Seldovia, Kodiak, and the Aleutian Island chain. Although cruise ships call on ports in Cook Inlet (primarily Anchorage and Homer), the inlet does not have the level of activity associated with cruise ships that southeast Alaska or Prince William Sound have. In 2014, Holland America's cruise ship *Amsterdam* made four port calls at Anchorage and Homer, and the *Silver Seas* made one port call at Homer (Cruise Line Agencies of Alaska, 2015). Cook Inlet is only projected to experience 6 to 18 visits by cruise ships each year for the rest of the decade (Cape International, 2012). In southcentral Alaska and the Cook Inlet area, spending in the recreational and tourism industries accounts for 7% of employment and 3% of income (McDowell Group, 2015).

Cook Inlet's many year-round recreational opportunities require some access to the outdoor environment. Many recreational activities involve public lands, whereas others use public water bodies. Activities that depend on the use of public water bodies may be classified as "coastal-dependent" or "coastal enhanced" (USDOI, MMS, 2003). Coastal-dependent activities require access to the coastline and water for the activity to take place. They include boating, sailing, kayaking, marine wildlife viewing, beachcombing, and fishing. (Sport fishing is addressed in Section 3.3.7). In contrast, coastal-enhanced activities do not directly depend on access to the coastline and water. Rather participants in these activities derive increased experiential quality due to coastal proximity. Coastal-enhanced recreational activities include hiking, biking, running, nature appreciation, camping, photography, and horseback riding.

Although more recreation and tourism in the Cook Inlet area occurs during the summer months, Cook Inlet offers a variety of winter recreational activities as well. They include cross-country skiing, ice fishing, snowmachining, hunting, snowshoeing, and dog mushing.

National Parks, State Parks, and Other Special Areas

Within or near the proposed Lease Sale Area, a variety of resources exist that support outdoor recreational opportunities of regional, statewide, and national significance. These resources include national parks; NWRs; national preserves; and State of Alaska resources (recreational areas, parks, and similar places). Figure 3.3.6-1 shows the distribution of these major resources, which are briefly described below.

Lake Clark National Park and Preserve

The Lake Clark NPP is a remote, rugged, wilderness park on the western side of Cook Inlet. The park encompasses almost 2.6 million ac (1.05 million ha) of undeveloped land. The preserve adjoins the park to the south and west and encompasses another 1.4 million ac (0.57 million ha). A large portion of the Lake Clark NPP is designated wilderness. Together, the park and preserve include the rugged Chigmit Mountains, active volcanoes, dramatic glaciers, wild rivers and scenic lakes, boreal forests, open expanses of tundra, and jagged coastlines. The varied topography creates habitats for a diverse mix of plants and animals.

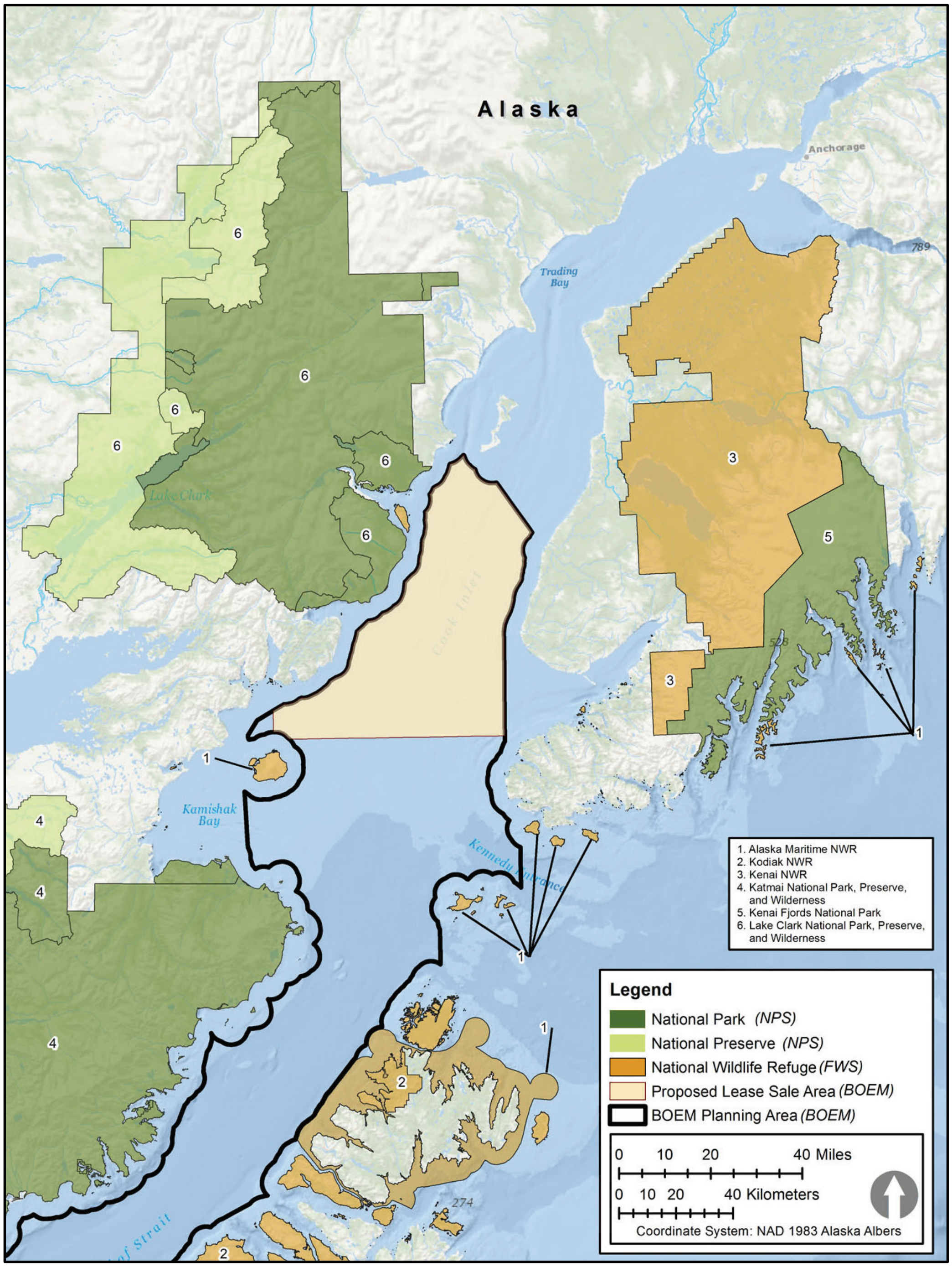


Figure 3.3.6-1. Relevant National Parks, Preserves, and Refuges.

The Lake Clark NPP is not on the road system. Consequently, visitors must fly or take a boat across Cook Inlet to access the area. Fixed-wing aircraft are allowed to land on all suitable lakes, rivers, beaches, gravel bars, and open ground in both the park and preserve unless the area is closed or otherwise restricted. Air charter services provide access to most points within the park and preserve. Some charter boat services offer tours that include portions of the park's coastline as well as drop-off and pick-up services. Most of the coastal lands along Cook Inlet between Chinitna and Tuxedni bays are primitive, and ideally suited for backpacking.

The park provides habitat for caribou, wolves, moose, bears, birds, and fish. Dall sheep are found at higher elevations, particularly on the western side. Caribou occur from the northern boundary of the park and preserve to the western boundary, north and south of the Mulchatna and Chilikadrotna Rivers. Brown bears are abundant along the coastal streams of Cook Inlet, where salmon spawn from June through September. The coast also is an important migratory bird route.

Katmai National Park and Preserve

The Katmai NPP is located on the northern Alaska Peninsula outside, but immediately southwest, of the Cook Inlet proposed Lease Sale Area. This 1.6 million ha (4-million ac) park was created to protect, study, and interpret active volcanism surrounding the Valley of Ten Thousand Smokes, extensive coastal resources, and habitats supporting a high concentration of salmon and brown bears. The entire coast of the park, including all offshore islands within 8 km (5 mi) of the mainland, is designated wilderness.

As with the Lake Clark NPP, the Katmai NPP is not accessible by car, but is almost exclusively accessed by plane or boat. Regularly scheduled commercial flights to King Salmon are available from Anchorage. Although much of the area is rarely visited because of its remoteness, some areas, such as Brooks Camp, are easily accessed by floatplane or boat, and have amenities, including lodging. Katmai NPP is one of the premier brown bear viewing areas in the world, and bears congregate at Brooks Camp to feed on salmon in the Brooks River. Companies permitted to operate in the park provide a variety of services, including transportation to the park, guided trips, overnight accommodations, and food service.

Kenai National Wildlife Refuge

The Kenai NWR was established as the Kenai National Moose Range in 1941 to protect moose habitat. The ANILCA altered the boundaries and purposes of the range and created the Kenai NWR. The refuge encompasses nearly 0.8 million ha (2 million ac) of the Kenai Peninsula. It is readily accessible by road and is only a 3-hour drive from Anchorage. More than 0.5 million ha (1.3 million ac) of the refuge are designated wilderness. The first significant oil field in Alaska was discovered in the Kenai NWR. Oil and gas development activities continue on approximately 89,000 ha (220,000 ac).

The refuge supports a rich diversity of habitats and species, with >200 species of birds, and mammals occurring on the refuge. The Chickaloon Watershed and Estuary is the major waterfowl and shorebird staging area on the peninsula and is the only estuary on the refuge. Salmon spawn in refuge waters. Rainbow trout and Dolly Varden are important for subsistence and recreational fishing. The refuge contains thousands of lakes, the largest of which are Tustumena Lake (30,000 ha (73,000 ac)) and Skilak Lake (10,000 ha (25,000 ac)). The refuge includes portions of the Kenai River, where there is a major salmon fishery.

The Swanson River and Swan Lake canoe routes provide refuge visitors the opportunity to experience a mix of habitats and wildlife. These canoe routes are the only nationally designated trails on refuges in Alaska. The Skilak Loop Area encompasses a variety of habitats, wildlife species, and scenic vistas. Because it is entirely accessible by road, it has been recognized as a valuable area for environmental education and interpretation, and wildlife-oriented recreation.

Alaska Maritime National Wildlife Refuge, Gulf of Alaska Unit

The Alaska Maritime NWR encompasses small islands, islets, rocks, reefs, spires, and headlands along the Alaskan coast. The refuge extends from Forrester Island in southeastern Alaska to Attu Island at the tip of the Aleutian Chain, and almost to Barrow on the Arctic Ocean. The Gulf of Alaska Unit is the portion of the refuge that includes islands and rocks in Cook Inlet.

The Tuxedni Bay area of the refuge is of particular interest for this analysis. Located offshore of the Lake Clark NPP in the western Cook Inlet northwest of Homer, the Tuxedni Bay portion of the refuge primarily is composed of Chisik and Duck Island. Tuxedni Bay is the home of seabirds, bald eagles, and peregrine falcons. Ducks commonly migrate through or winter on the refuge, and shorebird habitats are generally restricted by vertical sea cliffs and abrupt shorelines. Other raptors present on the refuge include rough-legged hawks (*Buteo lagopus*), northern harrier (*Circus cyaneus*), and short-eared owls (*Asio flammeus*). Forty-four species of songbirds have been reported in this unit of the Alaska Maritime NWR.

Approximately 2.5 million seabirds representing 23 species inhabit the Gulf of Alaska Unit of the Alaska Maritime NWR. Lagoons, bays, and coastal waters provide most of the waterfowl habitat on or adjacent to this unit 140 of the Alaska Maritime NWR and are used primarily for wintering and staging areas.

Kachemak Bay National Estuarine Research Reserve (KBNERR)

Kachemak Bay is the largest reserve in the NOAA Research Reserve System. The 141,640 ha (350,000-acre) reserve is approximately 240 km (150 mi) south of Anchorage on the western coast of the Kenai Peninsula. The reserve is one of the most productive, diverse, and intensively used estuaries in the State of Alaska. The local community pursued the designation of Kachemak Bay as a National Estuarine Research Reserve (NERR) to preserve the lifestyle and economy of the region. The reserve was established to increase understanding of the bay and its resources. Kachemak Bay features extensive tidal mudflats, subtidal habitat, and upland forests. The bay is 39 km (24 mi) wide at its mouth and approximately 58 km (36 mi) long. The southern shore is comprised of the Kenai Mountains, containing several glaciers that drain directly to Kachemak Bay.

State Resources

The State of Alaska has a variety of resources related to tourism and recreation adjacent to the Cook Inlet proposed Lease Sale Area. Alaska's state parks are the primary roadside gateways to outdoor recreation (ADNR, 2009c). State park units in the area include the Captain Cook, Clam Gulch, Ninilchik, Deep Creek, Stariski, and Anchor River State Recreation Areas. Kachemak Bay State Park and Wilderness Park also are within the area.

The State of Alaska manages state resources in the Cook Inlet area through a series of management plans. Some areas, such as the Kachemak Bay State Park and Wilderness Park have specific management plans. In 2001, the State developed the Kenai Area Plan to address the management of all state areas without a specific management plan. This plan addresses.085 million ha (2.1 million ac) of state uplands within the Kenai Peninsula Borough and 1.1 million ha (2.6 million ac) of state owned tidelands and submerged lands along the Outer Kenai Peninsula and in Cook Inlet (ADNR, 2001). The Kenai Area Plan addresses management of most of the state resources discussed below.

The Captain Cook State Recreation Area (1,465 ha (3,620 ac)) is located at the end of Kenai Spur Road on the northern portion of the Kenai Peninsula just northeast of the Cook Inlet proposed Lease Sale Area. Access to the area is available from mile 36 on the North Kenai Road, approximately 35 km (22 mi) northeast of Kenai. The recreation area encompasses forests, lakes, rivers, and saltwater beaches; offers swimming and canoe landing; and is the terminal point for the Swanson River canoe trails, picnic areas, and camping. Sport fishing is available all year. Moose, bald eagles, waterfowl, and bears are commonly seen in the park. On the coast, the offshore oilrigs in Cook Inlet can be seen with the Alaska Range in the background. Rock collectors, beachcombers, and driftwood collectors are attracted to the beaches.

The Clam Gulch State Recreation Area is located at mile 117 on the Sterling Highway. This recreation area provides access to one of the most popular razor clam-digging beaches on Cook Inlet. However, the state has closed the eastern Cook Inlet beaches to clamming at least for the rest of 2015 because the razor clam population has collapsed (ADFG, 2015a). A four-wheel drive road provides access to the beach for vehicles and pedestrians. Camping and picnicking facilities are available.

The 97-acre Ninilchik State Recreation Area is located at mile 135 on the Sterling Highway, approximately 61 km (38 mi) north of Homer. This recreation site offers excellent sightseeing. Mt. Redoubt lies directly across Cook Inlet from Ninilchik. A Russian Orthodox Church, which was built in 1900, overlooks the picturesque Ninilchik village. The site offers both commercial and sport fishing for salmon and halibut.

The Deep Creek State Recreation Area is located at mile 138 on the Sterling Highway. This recreation site offers excellent fishing for salmon and halibut, and digging for razor clams and beachcombing are prime attractions. Coal washed up on the beach is used for fuel by local residents and visitors. A boat-launching facility for small crafts is available, and sanitary facilities and drinking water are provided.

The 12.1 ha (30 ac) Stariski State Recreation Area is located at mile 151 on the Sterling Highway on a high bluff overlooking Cook Inlet, 32 km (20 mi) north of Homer. The view is outstanding, and beluga whales are frequently seen in the inlet. Extensive mortality of spruce trees from the spruce bark beetle epidemic has cleared most of the spruce trees from this site.

Anchor River State Recreation Area is located at mile 157 on the Sterling Highway near Anchor Point, 24 km (15 mi) northwest of Homer. At the mouth of the Anchor River, this recreation area is a popular fishing area for halibut and king and silver salmon. Steelhead trout are a primary attraction in the fall and winter. This site is one of the best areas in which to observe seaside and alpine floral vegetation. An abundance of bird and sea life, including whales, can be observed in this area.

The Kachemak Bay State Park and Wilderness Park is located 3.2 km (2 mi) across the water southeast of Homer. Access is available from Homer by plane or boat. This minimally developed park encompasses 132,854 ha (328,290 ac) of wild mountainous terrain and magnificent ocean shoreline. Boating, beachcombing, fishing, and clamming are outstanding in the tree-lined bays, coves, and fjords. Harbor seals and archaeological resources dating back 2,000 yr may be seen on Chugachik Island. Glaciers fed by the Harding Icefield spill down over the Kenai Mountains. Approximately 75 miles of hiking trails are maintained in the park, with access to developed campsites. Six public use cabins can be reserved for use. A ranger station is located in Halibut Cove Lagoon and is the trailhead location for much of the hiking within the park. Numerous unnamed glaciers exist in this wilderness area. Kachemak Bay provides excellent fishing for halibut, salmon, shrimp, and Dungeness and Tanner crabs. Leisure Lake provides excellent rainbow trout fishing.

The McNeil River State Game Sanctuary is on the west coast of Cook Inlet adjoining the Katmai NPP. The State designated this sanctuary to protect the world's largest concentration of wild brown bears. As many as 144 individual bears have been observed at McNeil River through the summer, with as many as 74 bears observed at one time. Although all five species of Pacific salmon are present in the sanctuary, it is the chum salmon that primarily attracts bears to McNeil River between early July and mid-August. The sanctuary protects approximately 518 km^2 (200 mi^2) of wildlife habitat. This is an undeveloped roadless area with no modern amenities.

Other Recreational Opportunities

Although cruise lines service Homer and Anchorage, the volume of passengers at these two ports is a very small fraction of the volume of passengers sailing between Whittier and southeast Alaska (Alaska Department of Commerce, Community, and Economic Development (ADCCED), 2014). Tour boats and water taxis, however, are active in the central to lower Cook Inlet. For example, tour boats take tourists to various locations throughout the Kachemak Bay area to view wildlife and scenery, including Yukon Island, Tutka Bay, Moosehead Point, Gull Island, which hosts 15,000 seabirds, and 60-Foot Rock, which is home to a large concentration of sea otters and 500 seabirds.

Visitors also book lodging and commercial services throughout the Cook Inlet area. Lodging includes bed-and-breakfast and rental cabins and wilderness lodges, such as Kachemak Bay Wilderness Lodge, Silver Salmon Creek Lodge, and Redoubt Bay Lodge. Commercial services, such as guiding, outfitting, and transporting, support hunting and fishing excursions throughout the Cook Inlet proposed Lease Sale Area.

3.3.6.2. Visual Resources

Visual Study Area Definition

This section discusses the visual resources associated with the Kenai Peninsula and the 32 km (20 mi) visual study area. The criteria for defining the study area is determined by considering the distance at which the Proposed Action is no longer likely to create a perceivable impact. For this purpose, a viewshed analysis was performed to reveal the inland areas in which visibility tends to diminish rapidly. This analysis is described in further detail below and is shown in Figure 3.3.6-2.

To create the viewshed analysis, 30-Meter USGS Digital Elevation Models (DEMs) are imported into a GIS workspace. The center and multiple perimeter points around the proposed Lease Sale Area are used as control points, set at 200 ft above ground level (AGL). The GIS software then scans each of the 30-m cells within a 25 mi area. The scan assumes a 5.1-ft receiver elevation to simulate the viewer eye height to determine whether there is an uninterrupted line of sight to a proposed activity. If the cell is determined to have potential visibility, each of those cells is coded as visible. The resulting data layer includes a combination of those cells with project visibility. This result represents the geographic area in which the project activities would be visible under bare earth conditions. The bare earth viewshed result is considered the worst case visibility for a project and is inherently conservative since bare earth conditions do not exist in the proposed Lease Sale Area, and it does not consider screening by buildings. With the geographic area of visibility defined, it is possible to determine the point beyond which visibility is likely to diminish completely. Figure 3.3.6-2 shows that on the western side of Cook Inlet visibility diminishes even closer than 20 mi, due to the rugged mountainous landscape. On the east side, visibility becomes sparser near the 20 mi line. The open water portions of the study area are shown as solidly visible with the exception of the few islands that might block views. In the case of on-water views it may be necessary to test views from distances >20 mi, once a preferred action has been proposed. However, for the purposes of this Draft EIS, 20 miles is a sufficient study area.

The visual study area consists of a vast and variable landscape which includes open water, developed and undeveloped coastal areas, vast tracts of forested and scrub-shrub vegetation, perennial ice and snow in the higher elevations, and large areas of barren land (consisting of rock, sand or clay). The USGS National Land Cover Dataset was used to determine the distribution of cover types. The results are presented in Table 3.3.6-1, Figure 3.3.6-2, and Figure 3.3.6-3. The majority of the 70,940 km^2 (27,390 mi^2) study area consists of open water comprised principally of Cook Inlet. Cook Inlet is known as a tourist destination for whale watching, fishing and sightseeing. However, there are also existing oil exploration and extraction activities occurring within Cook Inlet. The combination of recreational activities and industrial operations has been a part of the Cook Inlet landscape for decades.

Beyond the water, the Kenai Peninsula landscape consists of the Cook Inlet Basin Ecoregion which is a low-lying area with numerous lakes, estuaries and river basins. Vegetation consists of low scrub shrub lots leading into large tracts of coniferous forest. Together these two cover types make up over 40% of the entire visual study area.

On the western side of the study area, bordering the Cook Inlet Basin Ecoregion, is the Alaska Range Transition Ecoregion. Here the thick forest cover becomes small and sparse, giving way to barren rock and eventually glacial perennial ice and snow. The Alaska Range is not within the visual study area, but is very relevant considering the fact it is a colossal backdrop of mountain peaks and glaciers upon which the lowlands and basin are framed.

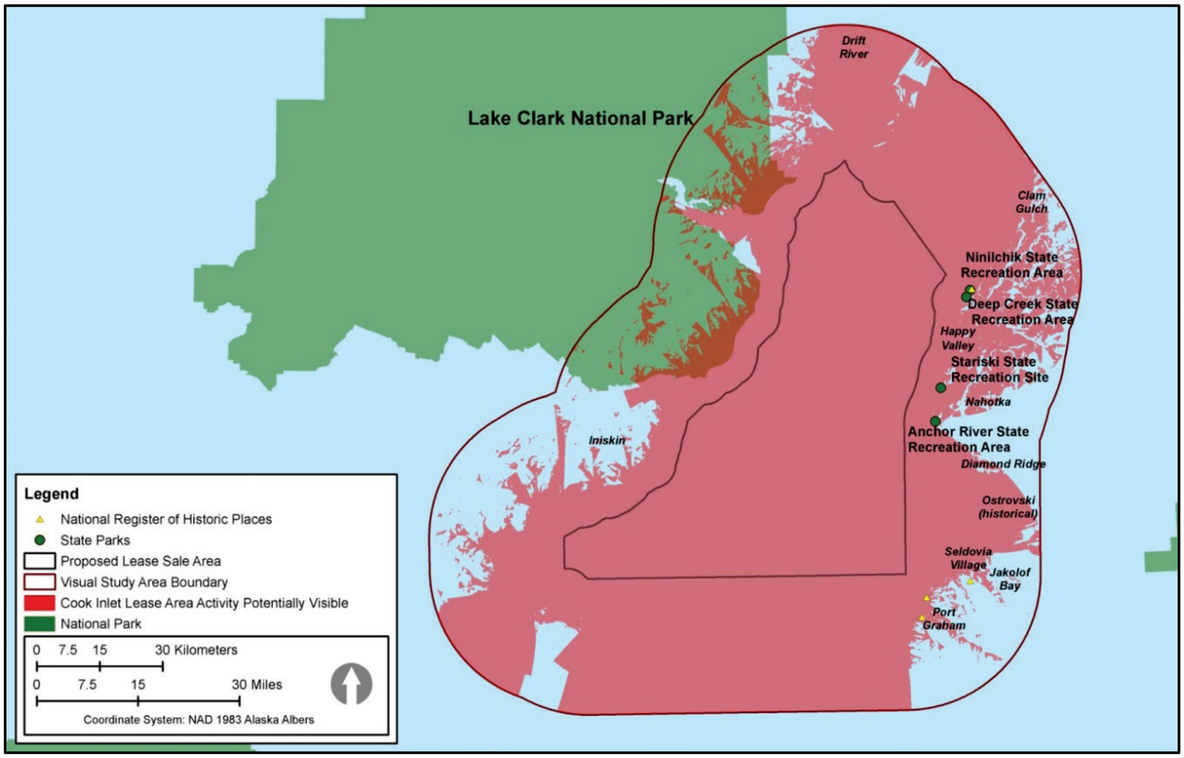


Figure 3.3.6-2. Visual Study Area of Cook Inlet as a Result of the Proposed Activities.

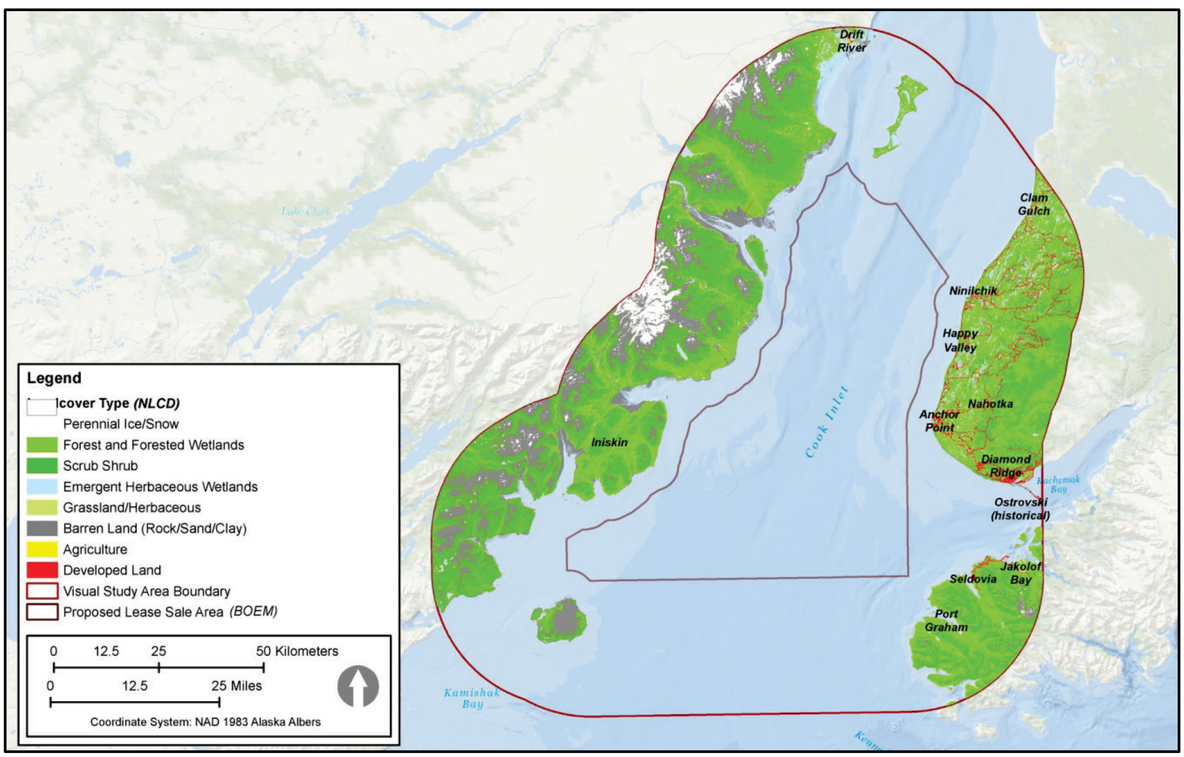


Figure 3.3.6-3. Land Cover Types within the Visual Study Area.

Developed land occurs almost exclusively on the eastern side of Cook Inlet. This generally consists of small residential communities and coastal villages which extend south from the city of Anchorage. In the southeastern portion of the visual study area is the Coastal Rainforest Ecoregion, hence this area is generally heavily forested, with the exception of the village of Seldovia.

Table 3.3.6-1. Land Cover Distribution in the Visual Study Area.

Land Cover Type	Percentage of Study Area
Open Water	55.41
Scrub Shrub	25.49
Forest	16.61
Emergent Wetlands	2.36
Developed Land	0.09
Perennial Ice and Snow	0.02
Barren Land	0.02
Grassland	0.01

Elevation

As mentioned in the land cover descriptions, the majority of the proposed Lease Sale Area is at sea level on Cook Inlet. Elevations across the entire study area range from 0 ft to approximately 945 m (3,100 ft). Higher elevations generally occur on the western side of the 20-mi visual study area. The remaining areas generally average between 15 m to 91 m (50 and 300 ft). Beyond the study area in the Alaska Range, elevations rise as high as 6,096 m (20,000 ft). This highly variable topography lends itself to a dynamic landscape which tends to have a relatively high scenic value.

Visual Resources

Resources that are considered visually sensitive generally consist of publicly accessible places and are cultural, recreational, historic or scenic in nature. Additionally, populated areas can be designated as scenic resources due to the concentration of potential stakeholders. Table 3.3.6-2 presents potential resources that should be considered visual resources. However, the table below does not represent a comprehensive list of resources. Additional resources may result from historical surveys and/or stakeholder input.

Table 3.3.6-2. Potential Visual Resources and the Distances from the Proposed Lease Sale Area as a Result of the Proposed Activities.

Scenic Resource	Distance from Lease Area (Miles)
National Parks	
Lake Clark National Park	3.6
State Parks	
Ninilchik State Recreation Area	4.1
Deep Creek State Recreation Area	3.9
Stariski State Recreation Site	3.6
Anchor River State Recreation Area	3.6
National Register of Historic Places	
Coal Village Site	4.6
Holy Transfiguration of Our Lord Chapel	4.3
St. Nicholas Chapel	9.6
Sts. Sergius and Herman of Valaam Chapel	7.1
Populated Places	
Anchor Point	4.8
Clam Gulch	16.5
Diamond Ridge	14.6
Drift River	18.0
Happy Valley	3.9
Homer	15.0
Iniskin	10.8
Jakolof Bay	16.9
Kachemak City	18.3

Scenic Resource	Distance from Lease Area (Miles)
Klutchevya	11.3
Millers Landing	18.4
Nanwalek	6.7
Nikolaevsk	11.1
Ninilchik	4.0
Ostrovski (Historical)	16.8
Port Graham	8.9
Seldovia Village	11.7

3.3.7. Sport Fishing

Marine sport fisheries of Cook Inlet play an increasingly important role in Alaska's recreation-based economy. Directly, sport-fishing benefits charter companies and fishing guides. Indirectly, marine sport fishing financially benefits tourism-related businesses including transportation, hotels, restaurants, gear shops, and other service-sector concerns. In addition, residents of Alaska benefit from license fees collected by ADFG, as these support enforcement, research, and preservation of sport and commercial fisheries resources.

In terms of catch, predominant marine sport fisheries of Cook Inlet target Pacific halibut, Pacific salmon, and razor clams (ADFG, 2005;, 2013). Between 1996 and 2013, halibut sport-fishing catch in Cook Inlet increased 20%, from an estimated 497,780 to 513,216 fish (ADFG, 2005, 2013). In 2013, halibut comprised 33% of Cook Inlet's marine sport fishery, its largest catch. While halibut dominates sport fishing in Cook Inlet, the marine salmon fishery (e.g., Chinook and coho) is also a key component of the Cook Inlet sport fishery. Salmon comprised 25% of the total marine sport fishery in 2013 (ADFG, 2013). However, total marine salmon sport fishing harvest decreased an estimated 8% between 1996 and 2013, from 439,289 to 403,305 individual fish per year (ADFG, 2013).

Commonly, those engaged in sport fishing, especially for halibut or salmon, hire a charter or participate in a guided tour. Historically, sport fishing charters and shore-based fishing have included the communities of Anchor River, Whiskey Gulch, Deep Creek, and Ninilchik River; other Cook Inlet sites and the Gulf of Alaska coast west of Gore Point; other Cook Inlet areas north of the Ninilchik River, Barren Islands, Seldovia, Homer Spit, Seward, and various points along the shoreline (Herrmann, Todd, and Hamel, 2001). In 2013, 58% of the sport fishing business licenses issued in Alaska were issued to guides residing in southcentral Alaska, which encompasses Cook Inlet (Sigurdsson and Powers, 2014).

Charter trips are conducted in either saltwater or freshwater. The number of saltwater charter trips taken in southcentral Alaska in 2013 totaled 19,453 (Sigurdsson and Powers, 2014). Of these trips, 1,993 targeted salmon, while 12,176 targeted bottomfish (e.g., Pacific halibut), and 5,260 trips targeted both species types. Statewide data indicate that most bottomfish-targeted charter trips occur in southcentral Alaska (i.e., Cook Inlet). Saltwater angler trips in southcentral Alaska totaled 138,648 in 2013 (Sigurdsson and Powers, 2014). Kachemak Bay and the rivers and streams flowing into Cook Inlet account for a large proportion of the total freshwater sport fishing effort for the entire state. 82% of freshwater charter trips recorded in 2013 took place in southcentral Alaska. Freshwater angler charter trips in southcentral Alaska totaled 91,892 in 2013 (Sigurdsson and Powers, 2014). Some of the most popular freshwater sport fishing occurs in the following locations on the Kenai Peninsula targeting the following fish:

- Kenai River Chinook salmon in June
- Russian River sockeye salmon in June
- Kasilof River Chinook salmon in June

- Lower Kenai Peninsula salmon at Deep Creek, Ninilchik Creek, Anchor River, Homer Spit, and Halibut Lagoon in June;
- Second-run Kenai River fishery in July; and
- Coho salmon fisheries on all rivers and streams on the Kenai Peninsula beginning in the latter part of July, and running through September, and later

Both freshwater and marine sport fishers include local fishers from the Kenai Peninsula, other Alaskans (from outside the Kenai Peninsula), and nonresidents of Alaska. While recreational fishing is popular among Alaskan residents, records indicate that charter sport fishing is not. In 2013, 79% of angler days recorded on saltwater bottomfish charters were attributed to nonresidents, and only 14% were attributed to residents (Sigurdsson and Powers, 2014). Halibut was the most harvested species, comprising 53% of fish takes. Similarly, 86% of angler days in the saltwater charter salmon sport fishery were attributed to nonresidents, and only 9% were attributed to residents. A similar breakdown was reflected in freshwater charter hires and residency: 89% of freshwater angler days of effort were attributed to nonresidents in 2013.

Cost may be one consideration for residents in relation to their avoidance of tourist-targeted charters. Average daily expenditures for lower Cook Inlet and central Cook Inlet sport-fishing trips in 2007 ranged from $162 for a local resident to $376 for a nonresident of Alaska; nonresident costs include travel expenditures (Southwick Associates Inc. et al., 2008). Additional costs included in these expenditures were for automobile or truck fuel, automobile or recreational vehicle rental, airfare, other transportation, lodging, groceries, restaurant and bar, hire of a charter or guide, fishing gear, fish processing, derby fees, boat fuel, and boat repairs, and moorage or haulout. Total expenditures by all sport fishers fishing in lower and central Cook Inlet directly attributable to a trip targeting saltwater halibut or salmon in 2007 was $99.3 million (Southwick Associates Inc. et al., 2008). Alaskan residents of the Cook Inlet area spend more on sport fishing than nonresident sport anglers, spending $457.9 million vs. $275.0 million, respectively, in 2007. This disparity is attributable primarily to equipment purchases.

Sport fisheries include gathering razor clams and other types of clams (for example, soft-shelled clam (*Myra* spp.) and the Baltic clam (*Macoma balthica)*) at various locations along the western side of the Kenai Peninsula, and other shoreline areas bordering Cook Inlet. Though not as popular as marine sport fishing, it is possible to book a guide or charter trip to hunt for razor clams or other bivalves in Cook Inlet. However, the sport fishery catch of razor clams has dropped in recent years; catch rates in 2013 were 65% lower than in 1996 (ADFG, 2005, 2013). Residents and nonresidents alike collect steamer clams, mussels, and various other shellfish in Kachemak Bay. For a description of the location of these species and their habitat, see Sections 3.2.1 and 3.2.2.

The saltwater sport fishery in Cook Inlet, freshwater sport fishery on the Kenai Peninsula, and clamming on the shores of Cook Inlet are an important part of the total economy. For more information on the economy of the Kenai Peninsula Borough, see Section 3.3.1. Sport fisheries also are an important part of recreation and tourism. For more information on recreation and tourism, and national and state parks, see Section 3.3.6.

3.3.8. Archaeological and Historic Resources

Archaeological resources are defined as any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest (30 CFR 250.105). The National Historic Preservation Act (NHPA, 54 U.S.C. 300101 *et seq.*) established a national program to preserve the country's historical and cultural resources. Section 106 of the NHPA requires all Federal agencies to consider the effects of their actions on historic properties listed on or eligible for the National Register of Historic Places. The tenets of the 106 process include, in consultation with identified interested parties, including the SHPO and Alaska Native tribes: identification of the area of potential effect of a Federal project; agreement on the reasonable and good faith identification effort; assessment of the project's impact on any cultural resources found during the identification effort; and development of measures to mitigate or minimize a Federal project's impact on historic resources. For the OCS, BOEM and the BSEE are the agencies charged with instituting procedures to insure that Federal plans and programs contribute to the preservation and enhancement of non-federally owned sites, structures, and objects of historical, architectural, or archaeological significance (USDOI, BSEE, 2016). BOEM and the BSEE have published guidelines (NTL 2000-A03 (superseded by NTL 2005-A03)) for performing archaeological surveys on the Alaskan OCS. These guidelines also include regulations concerning archaeological discoveries and report standards. Any archaeological survey in the OCS should make note of and incorporate the following best practices:

1. Regularly spaced parallel track lines and perpendicular tie-lines. Line spacing for archaeological identification should not exceed 30 m (98 ft). A minimum of three equidistant, perpendicular tie-lines should be surveyed; line spacing should not exceed 500 m (1,640 ft). A tighter line spacing may be required in some instances to provide for appropriate survey coverage and data quality.
2. Cable route surveys should consist of a centerline and three offset parallel survey lines on either side of the centerline for the entire route. Line spacing should not exceed 30 m (98 ft). Perpendicular tie-lines, spaced on 500 m (1,640 ft) intervals, should be surveyed throughout the length of the proposed corridor.
3. A magnetometer should be employed for all high-resolution geophysical surveys in water depths of ≤100 m (328 ft). The magnetometer height above the seafloor should not exceed 6 m (20 ft). Equipment sensitivity should be set at 1.0 gammas (1.0 nano-Tesla) and the sampling rate should be 4.0 Hz or greater to ensure sufficient data point density.
4. A side-scan sonar system should be employed to provide continuous imagery of the seafloor to identify potential archaeological resources. A sonar system operating at 500-kHz or greater is recommended and must be capable of resolving targets as small as 0.5 m (1.6 ft) in length. Instrument range should be set to provide at least 100% overlapping coverage, with the sensor towed at a height that is 10 to 20% of the range of the instrument.
5. A sub-bottom profiler system should be employed for identifying and mapping buried geomorphological features of archaeological potential that may exist within the horizontal and vertical footprint of a proposed action. The system should be capable of achieving a depth of penetration and resolution that is sufficient to allow for the identification and cross-track mapping of features of archaeological potential (e.g., shell middens, paleochannels, levees, inset terraces, paleolagoon systems, etc.). The subbottom profiler should be capable of achieving a resolution of vertical bed separation of at least 0.3 m (0.98 ft) in the uppermost 10 to 15 m (33 to 49 ft) of sediments, depending on the substrate.

The proposed Lease Sale Area includes the portion of the Cook Inlet Program Area north of Augustine Island, and south of Kalgin Island. In Alaska, oil and gas activities generally begin at the Federal/state offshore boundary at 4.8 km (3 nmi), with exceptions at predefined exclusion zones. In this discussion, "nearshore" refers to waters from the shoreline to the 30-m (98-ft) isobath, the approximate limit for ice gouging impacts. "Offshore" refers to the zone extending from the 30-m (98 ft) isobath to the outer boundary of the Cook Inlet Program Area.

3.3.8.1. Offshore Archaeological Resources

Prehistoric Resources

The prehistoric resource analysis assesses the potential for prehistoric archaeological resources to have occurred, survived, and be recoverable within the proposed Lease Sale Area. This analysis builds on the previous Prehistoric Resource Analysis completed for Cook Inlet Sale 191 and 199 (USDOI, MMS, 2003) and is based on an evaluation of various oceanographic, geophysical, and geotechnical data.

This analysis integrates geophysical/geological and archaeological information to determine the potential for prehistoric archaeological sites to occur and be preserved within the proposed Lease Sale Area. Preparation of the analysis is conducted in the following manner:

- Review of relative sea level data to determine the best estimate of relative sea level positions during the late Pleistocene and Holocene for the proposed Lease Sale Area. Blocks not above sea level during times of potential human habitation will require no further pre-lease prehistoric resource analysis or post-lease prehistoric resource reports.
- Examination of any USGS geology report or existing shallow hazards survey data for indications of significant landforms. If sufficient data exist to make a determination, those blocks that do not contain significant relict Pleistocene or Holocene landforms will require no further pre-lease prehistoric resource analysis or post-lease prehistoric resource reports.
- Examination of geophysical and geological data for information regarding natural geologic processes that might have destroyed prehistoric resources within the proposed Lease Sale Area or rendered them likely unrecoverable. Examples of such forces and processes include, but are not limited to: (a) glacial scouring; (b) sea-ice gouging; (c) shore-face erosion; and (d) excessive sedimentation. An area will require no further pre-lease prehistoric resource analysis or post-lease prehistoric resource reports if existing data indicate that natural geological processes have occurred to an extent and depth that prehistoric resources would not have survived and/or are not recoverable.

The following sections provide an update to the EIS for Cook Inlet Lease Sale 191 and 199 (USDOI, MMS, 2003).

Previous Studies and Modeling

Exactly how people came to settle in North America is subject to debate, but most archaeologists believe people migrated to North America between 17,000 and 14,000 yr B.P. across Beringia, a now submerged land bridge that spanned modern day Siberia and Alaska. Current research illustrates this land bridge existed prior to 18,000 yr B.P., which suggests it may have been possible for people to have populated North America earlier (Dixon, 2013). Previously it was thought that people settled the Cook Inlet region by approximately 3,000 yr B.P. (de Laguna, 1975), but new research suggests that human activity may have ensued as early as 8,000 yr B.P. (Klein and Zollars, 2008). Evidence of the extent of prehistoric maritime people living along the early Holocene coastlines of Cook Inlet may exist in the sedimentary record (Evans, Flatman, and Flemming, 2014). The identification of submerged paleolandforms can provide information necessary to model the probability of the occurrence of submerged prehistoric archaeological sites.

Sea Level and Relict Landforms

Cook Inlet is a dynamic region that has changed dramatically throughout the late Pleistocene and early Holocene as a result of tectonics and glaciation. Cook Inlet's geological history is presented in detail in Section 3.1.2.3; the following discussion focuses on sea level and the potential for relict landforms in the region.

Sea level within Cook Inlet was approximately 55 m (180.5 ft) lower than it is presently at approximately 12,700 yr B.P. (Dixon, Stoker, and Sharma, 1986). Shugar et al. (2014) described a scenario in which marine transgression occurred until approximately 10,000 yr B.P., followed by a small regression during the Holocene, with modern levels attained by approximately 2,000 yr B.P. People may have migrated south of Beringia along the coast of North America as early as 16,000 yr

B.P. (Dixon 2011, 2013). Therefore, it is completely plausible that evidence of prehistoric coastal cultures exists anywhere ≤55 m (180.5 ft) depth. Based on these data, it does not seem probable for prehistoric archaeological material to exist deeper than the 60 m (196.8 ft) isobath.

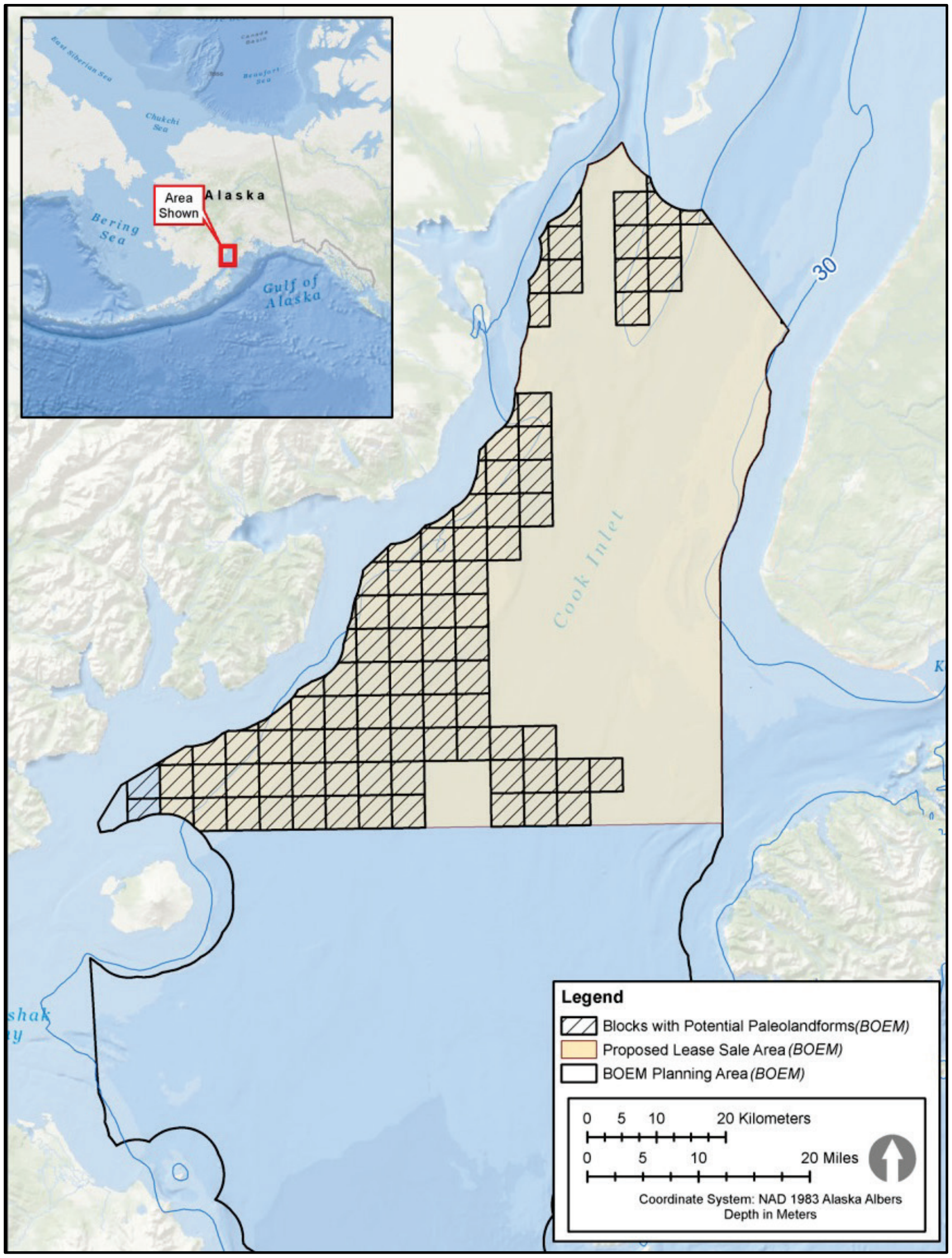


Figure 3.3.8-1. Cook Inlet Archaeological Resources.

Existing data suggest a potential for submerged prehistoric sites to exist within the proposed Lease Sale Area. Subsidence has occurred in Cook Inlet as a result of tectonic and isostatic forces, and therefore it is possible that some of the paleolandforms could be inundated terrestrial landscapes. Such terrestrial landscapes could very well be Geomorphological Province I and II (Thurston and Choromanski, 1995). Province I extends to the 60 m (196.8 ft) isobath, and is described as constructional morphology associated with glacial deposition. Province II (60 to 120 m (196.8 to 393.7 ft) depth) consists of erosional morphology with subordinate hydraulic erosion of glacial and marine deposits. Both provinces reflect the predominant influence of glacial movement, and are primarily represented by moraine deposits. For this reason, blocks that demonstrate bathymetric highs that are above the 60 m (196.8 ft) isobath would be considered high probability for prehistoric cultural resources, as these moraine sequences may once have been part of the terrestrial landscape. Furthermore, all blocks shallower than 60 m (196.8 ft) within regions of low velocity currents also are considered to be areas having a high probability of preserved archaeological deposits. Areas with historically large volumes of sea ice and icebergs, where surface scouring or large glacial rock deposits are visible, have lower probability of being sites where preserved archaeological deposits might be identified.

This analysis evaluated a total of 227 whole or partial blocks for their potential to contain paleolandforms. The following criteria have been developed to illustrate high probability locations for paleolandforms within the proposed Lease Sale Area:

- Block located shoreward of the 60 m (196.8 ft) bathymetric contour;
- Block contains known landforms conducive to prehistoric site locations or the existing information is inadequate to identify indicative paleolandforms;
- Block has ample Holocene sediment to inundate and preserve archaeological sites; and
- Block does not exhibit oceanographic conditions that are erosive and thus would provide a constructive environment for preservation.

Based on the Prehistoric Resource Analysis of the Cook Inlet proposed Lease Sale Area, a total of 100 whole or partial OCS blocks meet the above criteria (Figure 3.3.8-1). These blocks are recommended for further investigation, or avoidance by BOEM.

Historic Resources

The purpose of the shipwreck analysis is to provide an assessment of the potential for shipwreck resources in the proposed Lease Sale Area. Procedures for performing the analysis are outlined in the MMS (now BOEM) Handbook for Archaeological Resource Protection (USDOI, MMS, 1996) and include:

1. Complete a regional baseline study;
2. Review available shipwreck databases, and ascertain the size, type, and construction of any known vessels in the proposed Lease Sale Area;
3. Determine survey methods and instrumentation to detect shipwrecks in the proposed Lease Sale Area;
4. Examine geophysical/geological and oceanographic literature for information on the processes that would contribute to the preservation or destruction of shipwreck resources;
5. Identify areas with the potential to hold shipwreck resources and identify specific OCS blocks that would require an historic resources report (this part now superseded by the July 13, 2015 update, requiring surveying for all bottom disturbing activities).

The number of shipwrecks and obstructions in the proposed Lease Sale Area were estimated using information from various databases including the NOAA Automated Wreck and Obstruction Information System (AWOIS) updated January 2015), the NOAA Aids to Navigation (Navaids), NOAA Electronic Navigation Charts ENCDirect (updated January 2015), the USCG Hazards to Navigation, BOEM Alaska shipwreck database, and the Global GIS Data Services, LLC Global Maritime Wrecks Database (GMWD) (**Table 3.3.8-1**).

Table 3.3.8-1. Shipwreck and Obstruction Databases Consulted for the Cook Inlet Program Area.

Database	Information Provided	Extent of Data
NOAA AWOIS	Position (latitude/longitude), feature description, and any known historic and/or descriptive details. Positional accuracy of AWOIS wrecks and/or obstructions is highly variable and can have an error of as much as a 1 km (0.5 nmi) or more	Comprehensive
NOAA Navaids	Wreck locations, obstructions, platforms, submerged pilings, navigational aids, and light/channel markers	Moderate
NOAA ENCDirect	Lists wrecks as dangerous or non-dangerous and identifies source date and chart number	Limited
USCG Hazards to Navigation	Identifies wreck, obstruction, buoy, and unidentified object locations	Moderate
BOEM Alaska	Wreck name, date and cause of loss, lease block, vessel descriptive details, positional information, nearest landmark, location reliability, as well as references	Comprehensive
GMWD	Wreck name, wreck nationality, date of sinking, depth of wreck, vessel category, gross tons, sinking agent, nominal accuracy of wreck location, source of wreck, nationality of the vessel that sunk the wreck if applicable, and more	Comprehensive

A variety of secondary sources with information about shipwrecks within the proposed Lease Sale Area also were reviewed, including Berman (1973), Tornfelt and Burwell (1992), and USDOI, BOEM (2011b). Berman's (1973) encyclopedia includes shipwrecks dating from the pre-Revolutionary era to modern times, in coastal waters and inland waterways. Tornfelt and Burwell (1992) prepared a detailed compilation of Alaskan shipwrecks for BOEM. The report summarizes the historical contexts of shipwrecks in Alaska and provides a general discussion of shipwreck causes and locations. The shipwreck tables that dominate the report are organized by Planning Area and include information on vessel name, type, date of loss, location and cause of loss, tonnage, cargo, number of passengers and crew, and destination. The USDOI, BOEM (2011) shipwreck table includes information on vessel name, type, date of loss, year built, length/tonnage, location, a brief narrative of the loss, and source of information.

For several reasons, shipwreck databases have limitations. Many of the databases and secondary sources overlap, generating repetitiveness in data. A small number of these losses later have been found as salvaged, and returned to service after further research. Additionally, these sources are far from comprehensive. They tend to focus on large merchant vessels and omit the smaller coastal trading, fishing, and other locally built vernacular watercraft that may be present as shipwrecks in the nearshore zone of the proposed Lease Sale Area. Omission of smaller coastal watercraft from shipwreck databases would underestimate the number of shipwrecks in the nearshore zone.

The preservation potential of shipwrecks within Alaskan waters is dependent mainly on three factors: wave action/currents, ice, and temperature of the water column immediately above the seafloor. Wrecks located in nearshore areas frequently are subjected to intense wave action and currents from storms and ice gouging during the winter months. These environmental conditions are much reduced in the deeper waters of the OCS (>30 m (98 ft)) and wrecks located there have a greater potential for preservation. The coarse sands and gravels that comprise most of the Cook Inlet seafloor are formed in high energy areas, and shipwrecks located there would be exposed to increased scouring and erosion (Thurston and Choromanski, 1995).

Within Cook Inlet, volcanic activity further aids the preservation of shipwrecks through burial. There have been seven volcanic eruptions in the region in historic times. At least two area volcanoes, Mount Augustine and Mount Redoubt, located on the western side the proposed Lease Sale Area, have erupted more than once in historic times (Alaska Volcano Observatory, 2014a, 2014b). The low liquefaction potential and angular particle size of ash layers make them more stable than the overlying silt and clay layers and more resistant to erosion (USDOI, MMS, 2003). Since the 1912 Novarupta eruption at Katmai on the Alaska Peninsula, sediment accumulation has ranged from about 8 cm (3.1 in) in the northeastern part of the proposed Lease Sale Area to 84 cm (33 in) in the central part (USDOI, MMS, 2003).

Review of the above databases and secondary sources have identified 68 known wrecks, obstructions, archaeological sites, occurrences, or sites marked as "unknown" within or in the vicinity of the proposed Lease Sale Area (Table 3.3.8-2). The number of losses, however, should be considered underrepresented as there were undoubtedly many more sinkings that were not recorded due to the fact that there were no survivors to report the loss, and no witnesses from nearby vessels or shore. Even though many obstructions identified as "unknown" are eventually identified through diver or ROV investigation as modern trash or debris, those that have not been investigated cannot be ruled out as potential submerged cultural or historic resources. Table 3.3.8-2 lists the known historical shipwrecks located in the vicinity of the Cook Inlet proposed Lease Sale Area.

Table 3.3.8-2. Historic Shipwrecks in the Vicinity of the Cook Inlet Proposed Lease Sale Area

Vessel	Vessel Type	Date Lost	Cause of Loss	Source
A.S.P. No. 7	Steel Scow	5/22/1958	Foundered	USDOI, BOEM, 2011b
Acushla	Gas Screw	9/1/1927	Burned	USDOI, BOEM, 2011b
Agate	Gas Screw	7/12/1951	Foundered	USDOI, BOEM, 2011b
Agram	Cannery Tender, Gas Screw	10/12/1923	Swept ashore in storm	Tornfelt and Burwell, 1992
Alexander	Gas Screw	12/1/1925	Foundered	Tornfelt and Burwell, 1992
Alice	Schooner	7/10/1894	Drifted ashore and stranded	Tornfelt and Burwell, 1992
Alton	Schooner	5/27/1898	Lost in gale	Tornfelt and Burwell, 1992
Anita	Steamer	1898	Unknown	Tornfelt and Burwell, 1992
Balkom (Bolcom) No. 8	Barge	1924	Stranded	Tornfelt and Burwell, 1992
Bolcom No. 5	Scow	1924	Stranded	Berman, 1973
Bydarky	Gas Screw	9/4/1916	Burned, stranded ashore	Berman, 1973
Corea	Wood Bark	4/23/1890	Stranded	Tornfelt and Burwell, 1992
Craig Foss	Oil Screw	11/7/1965	Foundered	Berman 1973; USDOI, BOEM, 2011b
Delaware	Gas Screw	6/14/1931	Sank	Tornfelt and Burwell, 1992
Democrat	Gas Screw	8/12/1931	Foundered	Tornfelt and Burwell, 1992
Discoverer	Diesel Screw	12/23/1932	Foundered	USDOI, BOEM, 2011b
Discovery	Gas Schooner	12/5/1932	Wrecked	Tornfelt and Burwell, 1992
Donna Lee	Gas Screw	7/16/1954	Foundered	USDOI, BOEM, 2011b
Dynamite Kid	Oil Screw	5/4/1964	Foundered	USDOI, BOEM, 2011b
Elizabeth Mary	Wood Steamer	10/18/1892	Stranded	Tornfelt and Burwell, 1992
Farallon	Wood Steamer	1/5/1910	Aground and wrecked	Tornfelt and Burwell, 1992
Ferry Queen	Scow	10/7/1953	Foundered	Berman, 1973
Kandu	Marine Survey Vessel	12/1/1966	Foundered	USDOI, BOEM, 2011b
Kate Davenport	Bark (Barge)	1/10/1916	Stranded	Berman, 1973; Tornfelt & Burwell, 1992
Kenai I	Oil Screw	8/3/1948	Burned	Berman, 1973
Kentucky	Gas Screw	9/23/1926	Lost	Tornfelt and Burwell, 1992
Ketovia	Oil Screw	9/21/1962	Burned	Berman, 1973; USDOI, BOEM, 2011b
Lew-Al	Oil Screw	12/16/1959	Stranded	USDOI, BOEM, 2011b
Libby, McNeill, and Libby No. 2	Scow	8/2/1935	Wash ashore	Tornfelt and Burwell, 1992
Libby, McNeill, and Libby No. 9	Wood Scow	8/3/1932	Wash ashore	Tornfelt and Burwell, 1992
Lucky Boy	Gas Screw	7/22/1955	Stranded	USDOI, BOEM, 2011b
M.P.E. 110	Diesel Screw	4/12/1968	Foundered	USDOI, BOEM, 2011b
Maggie	Gas Screw	5/26/1953	Burned	USDOI, BOEM, 2011b
Mercury	Oil Screw	6/26/1968	Burned	Berman, 1973
Minneapolis	One-Masted, Gas Screw	10/16/1927	Sank	Tornfelt and Burwell, 1992

Vessel	Vessel Type	Date Lost	Cause of Loss	Source
Myrtle	Gas Screw	8/8/1932	Stranded	Tornfelt and Burwell, 1992
Olaf	Gas Screw	7/12/1924	Foundered	Tornfelt and Burwell, 1992
On Time	Gas Screw	1/1/1920	Stranded	USDOI, BOEM, 2011
Outline	Gas Screw	4/3/1905	Lost	Tornfelt and Burwell, 1992
P.G. No. 4	Scow	8/1/1924	Stranded	USDOI, BOEM, 2011b
Parks No. 2	Gas Screw	8/27/1955	Foundered	USDOI, BOEM, 2011b
Peggy Foss	Tug	11/24/1961	Destroyed by Ice	USDOI, BOEM, 2011b
Pete Tide	Oil Supply Rig	1/10/1970	Collided with oil platform, capsized, and sank	USDOI, BOEM, 2011b
Polly	Gas Screw	6/27/1965	Foundered	USDOI, BOEM, 2011b
Porifico No. 1	Gas Screw	8/5/1959	Burned	USDOI, BOEM, 2011b
Rea	Gas Screw	5/2/1965	Collided with unidentified object, sank	USDOI, BOEM, 2011b
Salmo	Gas Screw	9/28/1925	Burned	Tornfelt and Burwell, 1992
Salvator	Schooner	4/18/1905	Stranded	Berman, 1973; Tornfet and Burwell, 1992
Sandra	Gas Screw	7/11/1963	Stranded	USDOI, BOEM, 2011b
Seldovia	Barge	10/17/1928	Foundered	Berman, 1973; Tornfet and Burwell, 1992
Shamrock	Gas Screw	4/22/1929	Stranded	Tornfelt and Burwell, 1992
Skilak	Oil Screw	8/26/1969	Foundered	USDOI, BOEM, 2011b
South Wind	Tug	5/6/1967	Capsized	USDOI, BOEM, 2011b
Susitna	Gas Boat	11/11/1915	Lost	Tornfelt and Burwell, 1992
Thor	Diesel Fishing Tender	7/10/1952	Struck reef and sank	USDOI, BOEM, 2011b
Tinea	Gas Screw	7/1/1920	Lost	Tornfelt and Burwell, 1992
Torrent	Bark	Late 1868	Foundered and went ashore	Tornfelt and Burwell, 1992
Trio	Gas Screw	12/21/1927	Burned	Tornfelt and Burwell, 1992
Tri Sviatitelia (Three Saints)	Russian	11/30/1904	Wrecked, later burned	Tornfelt and Burwell, 1992
Uncle Sam	Diesel Screw	7/14/1958	Founderd	USDOI, BOEM, 2011b
Virginia	Gas Screw	7/10/1964	Foundered	USDOI, BOEM, 2011b
Washington	Bark	1870/1871	Blown ashore	Tornfelt and Burwell, 1992
Winabob	Diesel Screw	7/10/1954	Foundered	USDOI, BOEM, 2011b

3.3.8.2. Onshore Archaeological Resources

Cook Inlet Cultural Chronology

The Cook Inlet marine embayment presents an important physiographic and archaeological break in the steeply rugged coastline of the Gulf of Alaska, and provides a pathway between the Alaskan interior and North Pacific. In this setting, people and cultures dependent on terrestrial resources were juxtaposed with those utilizing marine resources. Initial archaeological research in the Cook Inlet region dates to the 1930s (de Laguna, 1975 (1934)), and the general culture history for Cook Inlet in published sources is based on investigations of archaeological sites on the Kenai Peninsula and upper Cook Inlet (Reger, 1998; Workman, 1998). In general, the eastern shore of Cook Inlet has been subject to greater systematic investigation than the western shore, and the Kenai Peninsula. Research has identified significant gaps in the archaeological record, particularly during the early and middle Holocene.

Early to Middle Holocene Technologies

Core and Blade Technologies

Few archaeological sites of great time depth are present in the Cook Inlet region (Klein and Zollars, 2008). The earliest known cultural stage recognized in Cook Inlet is characterized by the presence of core and blade lithic technology. Several core and blade sites are located along the Kenai River, as well as on Turnagain Arm in the upper inlet. Depositional contexts for these sites suggest an early Holocene age.

Side-Notched Projectile Points

During the mid-Holocene, approximately 4,000 to 5,000 yr B.P., side-notched projectile points appear in the upper Cook Inlet region. The points compare in form and age with material attributed to the Northern Archaic culture in more interior regions of Alaska (cf., Ackerman, 2004; Esdale, 2008), but little else is known about a possible notched point stage in the general Cook Inlet region.

Stemmed Points

At the Beluga Point site in the upper inlet, the second oldest component is characterized by an assemblage containing stemmed projectile points (Reger, 1998). This assemblage has no slate and is somewhat unreliably dated, with only typological comparisons forming the basis for an association with Ocean Bay-age material from Kodiak Island and the Katmai coast.

Ocean Bay Tradition

The Ocean Bay culture is described as an adaptation to the harvest of marine resources, especially large marine mammals, with a diverse assemblage of stemmed points and barbed bone darts, and an increasing use of ground slate over time. Based on research focused on Kodiak Island, the Ocean Bay groups practiced a relatively high level of residential mobility, inferred from the lack of permanent habitation sites found throughout the period (Fitzhugh, 2002; Tennessen, 2009). However, with increasing population growth and perhaps resource depression, a storage-based subsistence strategy emerged and became the hallmark of the subsequent cultural period known as the Kachemak Tradition. Ocean Bay sites are located on Kodiak Island, the Pacific Coast of the Alaska Peninsula, and in Kachemak Bay, dated from ca. 6,000 to 4,200 yr B.P. However, it has been suggested that the Ocean Bay occupation of Kachemak Bay lasted perhaps only one century (Workman, 1998).

Arctic Small Tool Tradition (ASTt)

A gap long existed in the cultural history of Cook Inlet between ca. 4,000 and 3,000 yr B.P., particularly in the upper Cook Inlet area (Reger, 1998; Workman, 1998). The presence of an Ocean Bay occupation sometime in that period comes from undated, scattered artifacts, as well as an Arctic Small Tool tradition (ASTt) occupation in Kachemak Bay dated to ca. 4,000 yr B.P. (Workman and Zollars, 2002). The only well-documented collections dating to this period are from the Magnetic Island site (KEN-00324), in Tuxedni Bay on Cook Inlet's western shore (Rogers et al., 2013). Occupation at the site was dated between ca. 3,400 and 3,800 cal yr B.P. Materials were attributed to the ASTt, and show clear affinity to similar such sites on western side of the Alaska Range and on the Alaska Peninsula (Dumond, 2005).

Kachemak Tradition

The Kachemak Tradition spans the period from approximately 3,500 to 800 yr B.P. While having close affinities to the preceding Ocean Bay cultures, the Kachemak Tradition is defined on the basis of increased storage and more substantial, permanent architecture (Dumond, 1998; Tennessen, 2009). In Cook Inlet, Kachemak Tradition sites occur in Kachemak Bay, Kamishak Bay, and on the central Kenai Peninsula along the Kenai and Kasilof Rivers (Reger, 1998; Workman, 1998). The Kachemak Tradition is characterized by salmon harvest along the major rivers, and by use of marine resources, marine mammals, and shellfish in southern Cook Inlet sites. Sites are classified as Marine or Riverine Kachemak based on the harvested resources and differences in artifacts used, although enough similarities exist to consider both types part of a larger Kachemak Tradition. Artifact similarities also extend to Kodiak Island and Shelikof Strait area sites (Clark, 1996). Kachemak Tradition sites in Cook Inlet generally date between 2,500 and about 1,500 yr B.P., although some sites along the Kenai River appear to last to about 1,000 yr B.P. (Reger and Boraas, 1996).

Late Prehistoric and Dena'ina Occupation of Cook Inlet

Late Prehistoric archaeology in Cook Inlet represents prehistoric remains of groups found historically by European explorers, primarily Dena'ina Athabaskans and Pacific Eskimo. Most archaeological sites north of Kachemak Bay which date within the last 1,000 years represent Dena'ina occupations. A boundary between the Pacific Koniag and Chugach Eskimo and Dena'ina in lower Cook Inlet is believed to extend from outer Kachemak Bay across Cook Inlet to the Kamishak Bay area (Townsend, 1981; Workman, 1998). The Cook Inlet Dena'ina maintained a unique mix of their traditional land hunting patterns, with acculturation of a presumably Alutiiq/Pacific Eskimo maritime economic adaptation (Reger and Mobley, 2008; Workman, 1998).

Historic Period

The first recorded contact between Europeans and the Dena'ina of Cook Inlet occurred in 1778, when Captain James Cook of the Royal British Navy sailed into the area in search of a Northwest Passage (Fall, 1981; Kari and Fall, 2003; Townsend, 1981). Cook reported that the inhabitants already possessed items of European manufacture, and assumed that they were indirectly trading with the Russians, who had established trading posts on Kodiak Island and the Alaska Peninsula. The Russians soon extended their direct influence into Cook Inlet, establishing forts at English Bay (Aleksandrovsk Fort), near present-day Kenai (Nikolaevski Fort), and at Iliamna and Tyonek (Fall, 1981). Kenai eventually became the main supply post for Russian trade in the wider Cook Inlet region.

Russia sold Alaska to the United States in 1867, and a short-lived U.S. Army post was established at the mouth of the Kenai River in 1869 (Fort Kenay, withdrawn in 1870). By the 1900s, with increased use of the area by the salmon-processing industry and shipping companies, Kenai expanded to become a port city. The development of homesteads during the 1940s and the first road link to Anchorage in the 1950s changed the historical landscape considerably. By the late 1950s, oil and gas discoveries near Kenai and in Cook Inlet contributed to a new period of development and growth throughout the region.

3.3.9. Areas of Special Concern

Cook Inlet includes lands designated by the ANILCA of 1980 as units of the NP, NWR, National Forest, Wild and Scenic Rivers, and National Wilderness Preservation Systems (P.L. 96-487). The following section describes land managed by the NPS, USFWS, and USFS, and describes Marine Protected Areas (MPAs), NERRs, NOAA-designated Habitat Conservation Areas (HCA), and several Alaska State resources managed by the ADFG that could be impacted by oil and gas activities or an associated spill. The Cook Inlet proposed Lease Sale Area includes only the northern portion of the Cook Inlet OCS Planning Area. Lands with coastlines that are adjacent to and in the vicinity of the Cook Inlet are likely to have higher probability of being impacted by oil and gas activities and therefore are discussed in greater detail.

3.3.9.1. National Park and Preserves

Lands managed by the NPS include parks, monuments and preserves, historic areas, and designated wild and scenic rivers. There are three NPs (Lake Clark, Katmai, and Kenai Fjords) and one national monument (Aniakchak) adjacent to or nearby the proposed Lease Sale Area.

Lake Clark National Park and Preserve

Lake Clark NPP is located approximately 160 km (100 mi) southwest of Anchorage, and encompasses a total area of 16,309 km^2 (6,297 mi^2) (Figure 3.3.9-1) (NPS, 2015). It protects a variety of habitats and physical features including mountains and volcanoes, glaciers, lakes and rivers, including three designated as national wild rivers (the Chilikadrotna, Mulchatna, and Tlikakila Rivers), boreal forests, alpine tundra, bogs, sedge meadows, shrubland, coastal salt marshes, and a coastline that runs along the northwest portion of the proposed Lease Sale Area. The coastline portion of the park runs for 198 km (123 mi) from Chinitna Bay northward along Tuxedni Bay to Redoubt Point (NPS, 2013, 2015).

Several animals utilize the different habitats: 37 species of terrestrial mammals, the wood frog (*Lithobathes sylvaticus*), 190 species of birds, and 25 species of fish, including salmon, Arctic char (*Salvelinus alpinus*), Arctic grayling (*Thymallus arcticus*), Dolly Varden, northern pike (*Esox lucius*), lake trout (*Salvelinus namaycush*) and rainbow trout (NPS, 2013, 2015). Waterfowl, shorebirds, song birds, moose, river otters, and other small mammals utilize coastal salt marshes. Bears (*Ursus spp.)* utilize sedge meadows following winter hibernation and transition to salt marsh streams as salmon begin to enter these waterways. Salt marshes comprise <1% of Lake Clark NPP, yet are critical to the survival of coastal brown bears due to a high concentration of food sources (NPS, 2015). Rivers are home to salmon, trout, and grayling, as well as ducks, swans, and other waterfowl. One of the primary reasons Lake Clark NPP was established was to protect a portion of the Bristol Bay watershed for the perpetuation of the sockeye salmon fishery (P.L. 96-487). The world’s most productive sockeye salmon spawning habitat is the Kvichak watershed (NPS, 2015). Bears, wolves, and other wildlife are often found along lake shores and river banks in search of fish. Caribou make their homes on the tundra, as do other terrestrial animals.

Katmai National Park and Preserve

Katmai NPP covers an area of 16,219 km^2 (6,263 mi^2) (Figure 3.3.9-1) (NPS, 2015). The park encompasses part of the Aleutian mountain range, several volcanoes (e.g., Mount Katmai), and the Nushagak-Bristol Bay Lowlands. Katmai NPP contains vast multi-lake watersheds with hundreds of miles of rivers that link freshwater and marine aquatic systems. Douglas River and Kamishak River flow into Kamishak Bay and Cook Inlet (NPS, 2015). The park has a coastline that runs from Akumwarvik Bay to Cape Kubugakli. The main purpose of the park is to protect the habitats and populations of fish and wildlife including, but not limited to, high concentrations of brown bears (*Ursus arctos horribilis*) and their denning areas; to maintain unimpaired the water habitat for significant salmon populations; and to protect scenic, geological, cultural, and recreational features (P.L. 96-487).

Forty-two species of mammals reside in Katmai NPP. Brown bears and moose reside in the coastal and lake regions, and other coastal mammals include sea lions (Otariidae), sea otters, hair seals (Arctocephalinae), and porpoises (Phocoenidae) (NPS, 2015). Birds are abundant throughout the year on the coastline. Black oystercatchers (*Haematopus bachmani*) are common birds in the intertidal zones. Breeding colonies of alcids, including common murres (*Uria aalge*), horned puffins (*Fratercula corniculata*) and tufted puffins (*F. cirrhata*), and black-legged kittiwakes (*Rissa tridactyla*) and other gulls, and are found on rocky headlands and offshore islands. Common goldeneyes (*Bucephala clangula*), and harlequin ducks (*Histrionicus histrionicus*) become abundant in winter. Sockeye salmon run up rivers, lakes, and streams for spawning during the summer, and spawn between August and October. Salmon provide food for the bears, bald eagles, rainbow trout, and other animals that forage along these streams (NPS, 2015).

Kenai Fjords National Park

Kenai Fjords NP is located on the Kenai Peninsula east of Cook Inlet and encompasses an area of 2,711.3 km^2 (1,046.9 mi^2) (Figure 3.3.9-1) (NPS, 2015). The park's coastline is dominated by fjordal estuarine ecosystems. While the park is outside the proposed Study Area, it could be affected by a spill event. Several marine and terrestrial mammals as well as over 191 bird species can be found in the park or along the coastline (NPS, 2015).

Aniakchak National Monument and Preserve

The Aniakchak National Monument and Preserve (ANMP) covers an area of approximately 2,080 km^2 (803 mi^2) (P.L. 96-487) (Figure 3.3.9-1). The coastal portion of the preserve runs from Cape Kunmik to Kujulik Bay. The purpose of the ANMP is to protect, study, and interpret the dynamic geology, ecology, and human use of Aniakchak Caldera and the surrounding landscape (NPS, 2009). Species protected on these lands include, but are not limited to, fish, brown bears including brown bears, moose, caribou, sea lions, seals and other marine mammals, geese, swans, and other waterfowl (P.L. 96-487).

The preserve is prime habitat for several terrestrial mammals, waterfowl, sea otter, harbor seal, sea lion, numerous smaller species, and fish and shellfish. All five species of Pacific salmon use the waterways in the preserve, and there are nursery areas for sockeye salmon runs that are part of the Bristol Bay and Kodiak/Chignik sockeye fisheries (NPS, 2015).

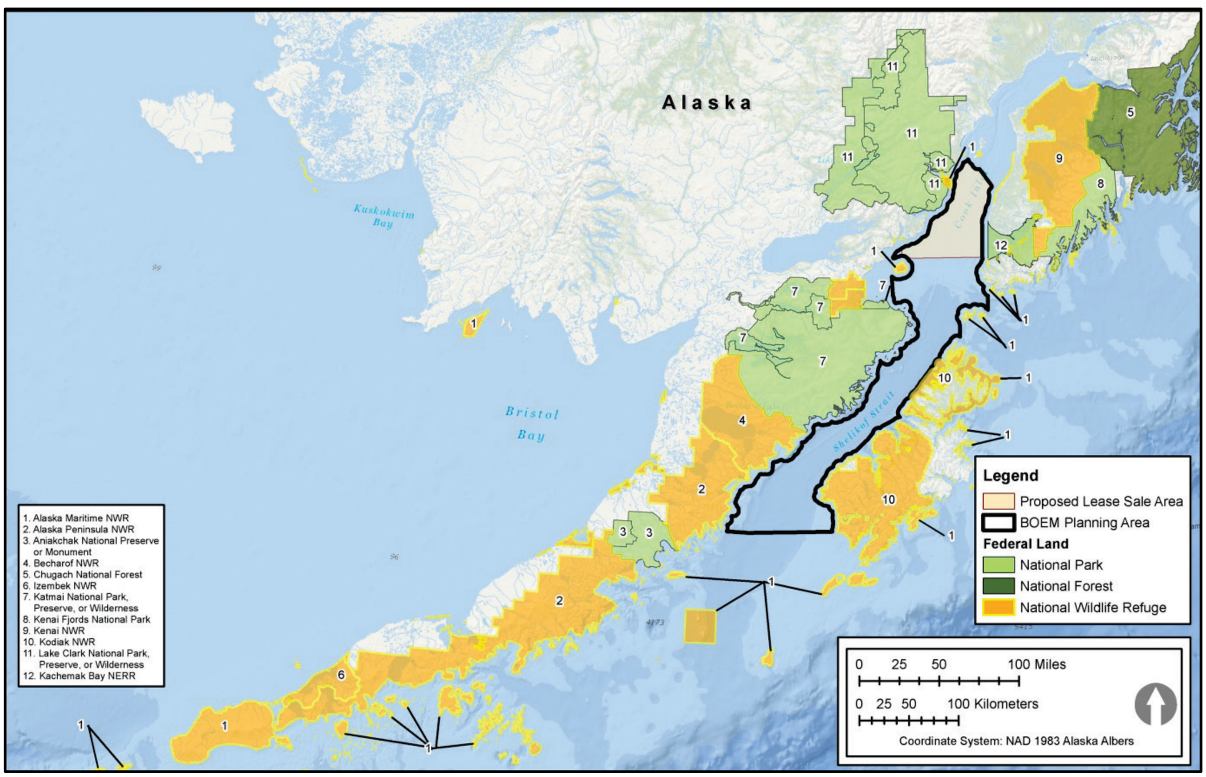


Figure 3.3.9-1. Federal Parks and Preserves in the Cook Inlet Area.

3.3.9.2. National Estuarine Research Reserves

Kachemak Bay National Estuarine Research Reserve

The NERR System is a partnership between NOAA and the coastal states. Kachemak Bay NERR (KBNERR) is located approximately 241 km (150 mi) south of Anchorage, encompasses a total area of 1,505 km^2 (581 mi^2), and extends along >515 km (320 mi) of Alaska's shoreline (Figure 3.3.9-1).

The mouth of the bay is located in close proximity to the southeastern portion of the proposed Lease Sale Area. Average water depth is 46 m (150 ft), the seafloor is relatively flat, and the tidal range is 8.7 m (28.5 ft) (KBNERR, 2012). The KBNERR is managed by the ADFG's Division of Sport Fish, and NOAA, with input from community members and other state and Federal agency partners (NERR, 2015). The mission of KBNERR is to enhance understanding and appreciation of the estuary and nearby waters and ensure that they remain healthy (KBNERR, 2012). Additionally, the KBNERR is meant to provide opportunities for long-term research.

Kachemak Bay is characterized by extensive tidal flats, braided drainages, and marshlands. The northern shore is characterized by shallow mudflats and the southern shoreline is characterized by rock cliffs, deep embayments, rocky intertidal habitats interspersed with beaches, and scattered islands (KBNERR, 2012). Several major glacial streams discharge into inner Kachemak Bay: Fox, Martin, Wosnesenski, and Bradley Rivers; and Sheep, Battle, Halibut, Portlock and Grewingk Creeks. In addition, several minor nonglacial streams discharge into Kachemak Bay along the southern shore. The northern coast is drier, and only eight small, nonglacial streams of limited drainage enter the inner bay from that side (Trasky et al., 1977). Kelp forests dominate the seafloor and provide habitat for fish, crab, and other small invertebrates. The reserve habitats also support birds; terrestrial mammals; large concentrations of marine mammals including whales, porpoises, Steller sea lions, seals, and sea otters; flatfish, walleye pollock, halibut, cod, herring, and all five species of Pacific salmon; Tanner crab, Dungeness crab and king crabs, and several species of clams (KBNERR, 2012).

3.3.9.3. National Wildlife Refuges

The NWR system is a network of U.S. lands and waters managed by the USFWS specifically for the enhancement of wildlife. There are currently 6 NWRs located adjacent to the proposed Lease Sale Area. All land within the NWR system is managed toward the goal of conserving and restoring the nation's fish and wildlife habitat. Management approaches and conservation methods differ among NWRs but typically include managing and rehabilitating wildlife habitat, controlling invasive species, and assisting in the recovery of rare wildlife species (USFWS, 2002).

Kenai National Wildlife Refuge

Kenai NWR is located on the Kenai Peninsula and is approximately 5,343 km^2 (2,063 mi^2) (USFWS, 2012b) (Figure 3.3.9-1). A portion of the refuge has some coastline along the Turnagain Arm in the upper Cook Inlet. The purpose of the Kenai NWR is to maintain the scenic and environmental integrity of the Harding Icefield glaciers, coastal fjords and islands; and to protect wildlife such as seals, sea lions, other marine mammals, and marine and other birds, as well as hauling and breeding areas (P.L. 96487). Prior to this designation, the refuge was designated to protect moose habitats (USFWS, 2012b).

Kenai NWR is characterized by the Harding Icefield and its glaciers, mountain tundra, boreal forests, lakes, rivers, and wetlands (USFWS, 2012b). The northeastern portion of the refuge is dotted with hundreds of small lakes surrounded by wetland tundra or spruce/hardwood forest hills. This large wetland habitat supports migratory breeding birds, shorebirds and terrestrial mammals. The Chickaloon River Flats are a major saltwater estuary on the Kenai Peninsula and are a staging area for thousands of shorebirds and waterfowl (USFWS, 2012b). There are numerous lakes and rivers in the refuge. The refuge is drained by nine river systems, including the Kenai River. The lakes and rivers support a spawning habitat for a variety of fish species, such as rainbow trout, Dolly Varden, Arctic char, five salmon species, and sticklebacks (Gasterosteidae). Moose, beaver (*Castor canadensis*), bald eagles, and mergansers (*Mergus spp.*) are commonly seen along the refuge's river systems, and brown bears and black bears utilize the fish resources in summer and fall (USFWS, 2012b).

Alaska Maritime National Wildlife Refuge

The Alaska Maritime NWR consists of a variety of habitats including mountains, rivers, lakes, volcanoes, and fjords, and also contains >2,500 islands, islets, spires, rocks, reefs, waters and headlands (USFWS, 2014f) (Figure 3.3.9-1). The refuge encompasses >20,000 km^2 (7,722 mi^2) and supports nesting habitats for an estimated 40 million seabirds. The refuge was established to conserve animal populations and habitats in their natural biodiversity including marine mammals, marine birds, and other migratory birds, and the marine resources upon which they rely, as well as fish and terrestrial animals (P.L. 96-487). Additionally, the refuge is meant to provide opportunities for research on marine resources, and subsistence uses for local residents, and to ensure water quality within the refuge (P.L. 96-487; USFWS, 2014f).

In order to manage such a large area, the refuge has been divided into five regional management units: the Alaska Peninsula, Aleutian Island, Bering Sea, Chukchi Sea, and Gulf of Alaska Units. Of interest to this Draft EIS, are portions of the refuge in the Gulf of Alaska Unit, some of which are found in the Cook Inlet adjacent to the proposed Lease Sale Area, for example, Duck Island and Chisik Island in Tuxedni Bay. These two islands originally were established as a refuge for seabirds, bald eagles, and peregrine falcons (USFWS, 2012a). Also protected in Tuxedni wilderness area are large colonies of sea birds, black-legged kittiwakes, horned puffins, common murres, pigeon guillemots (*Cepphus columba*), and glaucous-winged gulls (*Larus glaucescens*). Endangered or threatened species include short-tailed albatross, Eskimo curlew (*Numenius borealis*), leatherback sea turtle (*Dermochelys coriacea*), Steller sea lion, bowhead whale (*Balaena mysticetus*) humpback whale, Steller's eider, spectacled eider, Alaskan breeding populations, lynx (*Lynx canadensis*), and sea otter (USFWS, 2012a).

Marine mammals of the Alaska Maritime NWR include northern fur seal, endangered Steller sea lion, and harbor seals, including their rookeries and haulout sites (USFWS, 2014f). Other marine mammals include sea otters and several whale species. There are approximately 2.4 million sea birds that nest in the Gulf of Alaska Unit, the most abundant of which include Leach's storm-petrels (*Oceanodroma leucorhoa*), fork-tailed storm-petrels (*Oceanodroma furcata*), tufted puffins, and black-legged kittiwakes (USFWS, 2012a). Marine fish species include, but are not limited to, salmon, Dolly varden, cod, walleye pollock, halibut, or flounder (Pleuronectidae). Invertebrate species in the region include shrimp, clams, cockles, scallop, and Tanner crab, Dungeness crab, and red king crab (USFWS, 2014f).

Kodiak National Wildlife Refuge

Kodiak NWR covers an area of 7,690 km^2 (2,969 mi^2) (USFWS, 2012c) (Figure 3.3.9-1). The refuge has over 1287 km (800 mi) of coastline and tidal zones, 11 large lakes, seven river drainages, a number of smaller streams and tributaries, and several estuaries, shallow marshes, bogs, salt flats, and meadows. Wet and alpine tundra, lowland spruce forest, and dense vegetation cover the rest of the refuge. The main purpose of the refuge is to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, Kodiak brown bears, salmonids, sea otters, sea lions, and other marine mammals and migratory birds (P.L. 96-487; USFWS, 2012c).

Within the Kodiak NWR is the Kodiak brown bear, a genetically distinct subspecies with a population of approximately 3,500 individuals on Kodiak Island (USFWS, 2012c). Bird species that nest on cliffs, offshore rocks, and islands include black-legged kittiwakes, glaucous-winged gulls, horned and tufted puffins, pelagic cormorants (*Phalacrocorax pelagicus*) and red-faced cormorants (*P. urile*). Several duck species often are found in offshore waters of Kodiak Island, of which harlequin ducks, Barrow's goldeneye (*Bucephala islandica*), black scoter (*Melanitta americana*), common eiders (*Somateria mollissima*), common mergansers (*Mergus merganser*), and red-breasted mergansers (*Mergus serrator*) are year round residents (USFWS, 2012c). Kodiak Island is also home to bald eagles, Kittlitz's murrelet, and Steller's eider. The waterways contain salmonids which sustains a Kodiak-based fishing fleet.

Becharof National Wildlife Refuge

The Becharof NWR covers an area of 4,683 km^2 (1,808 mi^2) (USFWS, 2014g) (Figure 3.3.9-1). The eastern boundary and coastline is composed of swathes of sandy beaches, rocky coastline, and steep cliffs that run from Mount Kubugakli southwards to Island Bay. Found within the refuge are mountains, active volcanoes, alpine vegetation, wetlands, and Becharof Lake. The purpose of the refuge is to conserve fish and wildlife populations and habitats in their natural diversity. Animals in the refuge include, but are not limited to, brown bears, salmon, migratory birds, the Alaskan Peninsula caribou herd, and marine birds and mammals (P.L. 96-487). The Becharof and Alaska Peninsula are managed as one NWR unit.

Approximately 6 million sockeye salmon run in Becharof Lake annually and they support a wide range of wildlife (USFWS, 2014g). Fish (e.g., Dolly Varden, char, and Arctic grayling), brown bears, cormorants, terns, and bald eagles utilize salmon as a food source. All five species of Pacific salmon spawn in the streams and lakes in the refuge. The refuge is home to one of the 13 major caribou herds in Alaska, and numbers vary between 2,000 and 20,000 individuals (USFWS, 2014g). Seabirds, waterfowl, and shorebirds use the refuge primarily as a staging area during migration to and from nesting grounds in the Arctic. Several species use ponds, lakes, streams, and wetlands as breeding habitat. Migratory songbirds and raptors use shrub lands, tundra, and forest environments in the summer (USFWS, 2014g).

Alaska Peninsula National Wildlife Refuge

The Alaska Peninsula NWR covers an area of approximately 14,973 km^2 (5,781 mi^2) (USFWS, 2014h) (Figure 3.3.9-1). The refuge includes mountains, active volcanoes, broad valleys, fjords, tundra and glacially formed lakes, wetlands, coastal lowlands, and sandy beaches. The purpose of the refuge is to conserve fish and wildlife populations and habitats in their natural diversity. Animals include brown bears, the Alaska Peninsula caribou herd, moose, sea otters, other marine mammals, shorebirds and other migratory birds, raptors, including bald eagles, peregrine falcons, and salmonids and other fish (P.L. 96-487; USFWS, 2014h). The refuge is south of the Becharof NWR, and wildlife in the two are similar.

Izembek National Wildlife Refuge

The Izembek NWR is the smallest refuge in Alaska and encompasses an area of 1,274 km^2 (492 mi^2) (P.L. 96-487; USFWS, 2014i) (Figure 3.3.9-1). Most of the refuge is designated as wilderness containing a variety of fish and wildlife species including five species of salmon; wolf, fox, and wolverine (*Gulo gulo*); large mammals such as caribou, moose, and brown bears; shorebirds; seabirds; waterfowl; and marine mammals such as harbor seals, Steller sea lions, and sea otters, killer whales, gray whales, and minke whales. The refuge also contains Izembek Lagoon which supports one of the world's largest eelgrass beds (USFWS, 2014i). Over 90% of the black brant (*Branta bernicla nigricans*) population feeds and rests here, and the refuge supports over half the world's population of emperor geese (*Chen canagica*) and significant portions of Taverner's cackling geese (*Branta hutchinsii*) and Steller's eider (USFWS, 2014i)). Three lagoons in the region, the Izembek, Moffet, and Kinzarof lagoons, make up an IBA.

3.3.9.4. Chugach National Forest

Chugach National Forest

The Chugach National Forest covers portions of Prince William Sound, the Kenai Peninsula and the Copper River Delta, and is the closest national forest to the proposed Lease Sale Area. It encompasses

27,958 km^2 (10,794.6 mi^2) and includes extensive shorelines, glaciers, forests, and rivers supporting numerous avian, mammalian and marine species and providing shorebird habitat and a large bald eagle population (USDA, USFS, 2015). A majority of the Chugach Forest is outside the proposed Lease Sale Area (Figure 3.3.9-1). However, a portion of the national forest has some coastline along the Turnagain Arm in the upper Cook Inlet.

3.3.9.5. State Resources

McNeil River State Game Sanctuary and Refuge

McNeil River State Game Sanctuary is located southwest of the proposed Lease Sale Area and has an area of over 77 km^2 (200 mi^2) (ADFG, 2015a) (Figure 3.3.9-2). The sanctuary and refuge contain the McNeil River which drains into Cook Inlet in Kamishak Bay. The river provides habitat for salmon, which are used as food by brown bears. Animals such as red fox, Arctic ground squirrels (*Urocitellus parryii*), harbor seals and bald eagles are common. Moose, caribou, wolves, wolverine, as well as various furbearers, waterfowl, sea ducks and seabirds may be observed in the sanctuary (ADFG, 2015a).

Trading Bay State Game Refuge

Trading Bay State Game Refuge is located north of the proposed Lease Sale Area, on the west coast of Cook Inlet. The park contains wetlands and tidal flats and the area is best known for its waterfowl habitat (ADFG, 2015a) (Figure 3.3.9-2). The wetlands provide critical spring feeding, summer nesting, and fall staging habitat for thousands of ducks, geese, swans, and cranes. Brown bears forage on the tidal flats, and black and brown bears feed on salmon in the Noaukta Slough. Coho salmon, Chinook salmon, and sockeye salmon, rainbow trout, Dolly Varden, and smelt (*Osmerus spp.*) also are found in the refuge's streams and rivers (ADFG, 2015a).

Susitna Flats Game Refuge

Susitna Flats Game Refuge is located northeast of the proposed Lease Sale Area, in the upper portions of the Cook Inlet (Figure 3.3.9-2). The refuge contains sedge meadows, marshes, and intertidal mud flats (ADFG, 2015a). Susitna Flats is known for its high concentrations of migrating mallards (*Anas* spp.), pintails (*Anas spp*.), and Canada geese (*Branta canadensis*). Shorebirds include northern phalaropes, dowitchers (*Limnodromus spp.*), godwits (*Limosa* spp.), whimbrels (*Numenius spp.*), snipe (Scolopacidae), yellowlegs (*Tringa spp.*), sandpipers (*Actitis s*pp.), plovers (*Charadrius spp.),* and dunlin (*Calidris spp.*). From May to June, beluga whales congregate in the area extending from the Susitna River to calve, breed, and feed on eulachon fish. Moose utilize the Susitna Flats to feed in the winter and calve in the spring within the fringing brushy thickets. Within Cook Inlet, the Susitna River and its tributaries support the second largest salmon-producing system (ADFG, 2015a).

Goose Bay and Palmer Hay Flats State Game Refuges

These state game refuges are located in the Knik Arm in the upper portion of the Cook Inlet (Figure 3.3.9-2). These are important areas for birds, terrestrial mammals, and fish.

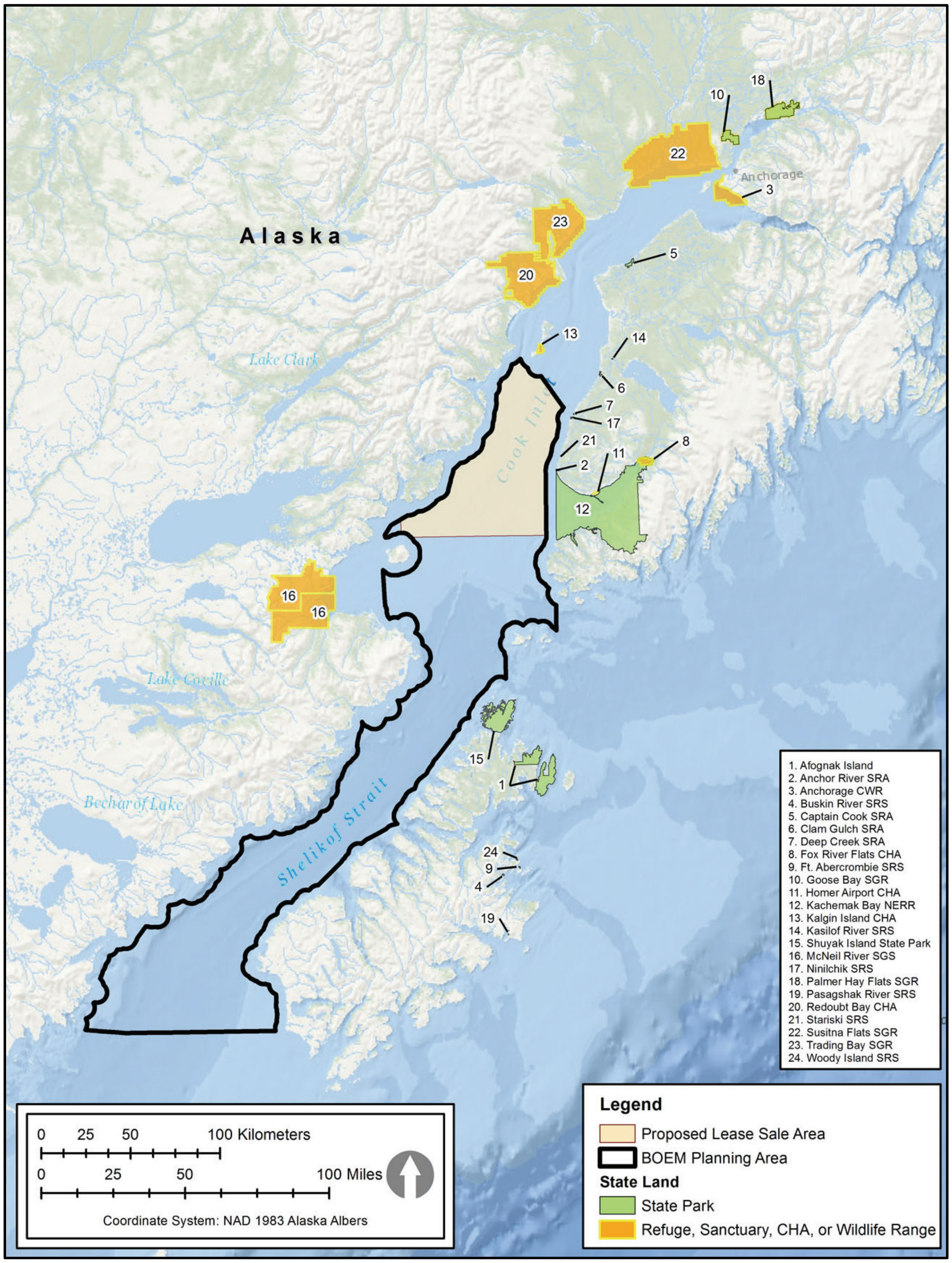


Figure 3.3.9-2. State Parks and Protected Lands around the Cook Inlet Area.

3.3.9.6. Anchorage Coastal Wildlife Refuge

Anchorage Coastal Wildlife Refuge is located northeast of the proposed Lease Sale Area, in the upper portions of the Cook Inlet (Figure 3.3.9-2). The refuge contains extensive tidal flats, marsh communities, and alder-bog forest (ADFG, 2015a). At least 130 bird species use this refuge, including waterbirds and shorebirds. Moose and various other terrestrial mammals are common in the refuge. Sticklebacks and sculpins (Cottidae) are ubiquitous.

3.3.9.7. Captain Cook State Recreation Area

Captain Cook State Recreation Area is located along the upper portion of Cook Inlet, northeast of the proposed Lease Sale Area (ADFG, 2015a) (Figure 3.3.9-2). Main features of the recreation area include the Stormy Lake and Swanson River, which has a shallow, silty estuary at its mouth. Beaches and mudflats are found offshore of the recreation area (ADFG, 2015a). The Swanson River and Stormy Lake are home to rainbow trout, coho salmon, and Arctic char. Mammals that visit the recreation area include moose, black bear, coyote, beaver, muskrat (*O. zibethicus*), and red squirrel (*T. hudsonicus*). Birds include thrushes (Turdidae), warblers (Parulidae), jays (Corvidae), mergansers (*Mergus spp.*), goldeneyes (*Bucephala spp.*), bald eagles, gulls (Laridae), and shorebirds. Wood frogs are found along the Swanson River. Small invertebrates, for example, amphipods, can be found beneath rocks at low tide (ADFG, 2015a).

3.3.9.8. Clam Gulch and Ninilchik State Recreation Areas

Clam Gulch and Ninilchik State Recreation Areas are located east of the proposed Lease Sale Area on the Kenai Peninsula (Figure 3.3.9-2). The Clam Gulch CHA also is located here, and runs from Cape Kasilof to Happy Valley. The region is famous for its razor clams, which are harvested annually on sandy beaches (ADNR, 2014b). Moose, bald eagles, gulls, many small birds, and mammals are found in the recreation areas. Beaches and Deep Creek are sites of recreational saltwater fishing for Chinook salmon. Birds include Canada geese, snow geese (*Chen caerulescens*), sandhill cranes (*G. canadensis*), mallards (*Anas* spp.), pintails (*Anas* spp.), green-winged teal (*Anas crecca nimia*), goldeneyes (*Bucephala sp.),* mergansers (*Mergus spp.*), buffleheads (*Bucephala spp.*), white-fronted geese (*Anser albifrons*) and various shorebirds (ADFG, 2015a). Ninilchik State Recreation Area is a popular staging area for world class salmon and halibut fishing (ADNR, 2014c). Other state recreation areas and sites are found here, including Kasilof River State Recreational Site, and Deep Creek, Anchor River, and Stariski State Recreation Areas. These areas are used for similar resources and activities.

3.3.9.9. Kachemak Bay State Park and Wilderness Park

Kachemak Bay State Park and Wilderness Park covers an area of approximately 1619 km^2 (625 mi^2) (ADFG, 2015a) (Figure 3.3.9-2). The parks contain mountains, glaciers, forests, ocean and portions of Kachemak Bay. Kachemak Bay is a CHA and it supports sea otters, seals, porpoises, and whales. Land mammals include moose, black bear, red squirrels, mountain goats, coyotes and wolves. The area is popular for birding and hosts eagles, gyrfalcons (*Falco rusticolus)*, puffins, sandpipers, and dunlins (Kachemak Bay State Park and Wilderness Park, n.d.; ADFG, 2015a).

3.3.9.10. Kodiak Area State Parks

There are six state parks in and around Kodiak Island: Shuyak Island State Park, Afognak Island State Park, Ft. Abercrombie State Historical Park, Woody Island State Recreation, Buskin River State Recreation Site, and Pasagshak River State Recreation Site (ADNR, 2014d) (Figure 3.3.9-2). The largest two are Afognak and Shuyak Islands, with areas of 303 km^2 (117 mi^2) and 189 km^2 (73 mi^2), respectively. Afognak has a rugged topography and contains old-growth Sitka spruce forests and salmon spawning habitat; Kodiak brown bear, Sitka black-tailed deer, Roosevelt elk, and the endangered marbled murrelet (*Brachyramphus marmoratus*) are found in the park (ADNR, 2014e). Shuyak Island's interior waterways are more sheltered than anywhere in the Kodiak Archipelago (ADNR, 2014f). Common sea animals include sea otters, whales, harbor seals, Dall porpoises, and birds. Kodiak brown bear and Sitka black-tailed deer inhabit the island's forests.

3.3.9.11. Critical Habitat Areas

Kalgin Island

Kalgin Island CHA is composed of wetlands surrounding Swamp Creek and is located north of the proposed Lease Sale Area (Figure 3.3.9-2). The CHA provides critical habitat for spring and fall resting and feeding habitat for swans, geese, ducks, and shorebirds. Other birds found in the CHA include greater yellowlegs, common snipe (*Gallinago gallinago*), northern harriers (*Circus cyaneus*), bald eagles, and Arctic terns (*Sterna paradisaea*). This CHA has a haulout site for harbor seals, and small mammals such as otters, beavers, and red-backed voles (*Clethrionmys oeconomus*) and tundra voles (*Microtus oeconomus*) can be found in or nearby the wetlands. Swamp Creek is an estuarine staging area for coho salmon (ADFG, 2015a).

Redoubt Bay

Redoubt Bay CHA is located north of the proposed Lease Sale Area (Figure 3.3.9-2). The CHA provides spring and fall resting and feeding habitat for waterfowl on their way to and from nesting grounds to the north. It is also an important waterfowl nesting area for ducks, geese, swans, and many other birds during the summer (ADFG, 2015b). Terrestrial mammals include moose, brown and black bears, coyote, fox, wolf, mink (*Neovison spp.*), river otter, marten (*Martes americana*), muskrat, wolverine, weasel (*Mustela sp.*), lynx, and beaver. Harbor seals have haulout locations in the mouths of streams. Beluga whales feed on salmon at the river mouths.

Fox River Flats

Fox River Flats CHA is located at the head of Kachemak Bay, east of the proposed Lease Sale Area (Figure 3.3.9-2). It is a component of the Kachemak Bay NERR (See Section 3.3.9.2). The flats serve as habitat for waterfowl and shorebirds. Terrestrial mammals use the flats while searching for food. The CHA is a haul out location for harbor seals, and beluga whales feed on salmon at the river mouths (ADFG, 2015c).

Kachemak Bay

Kachemak Bay CHA is a component of Kachemak Bay NERR, located east of the proposed Lease Sale Area (Figure 3.3.9-2). Description of the environment and wildlife is discussed in Section 3.3.9.2.

Clam Gulch

The Clam Gulch CHA is a component of the Ninilchik State Recreation Area and is located northeast of the proposed Lease Sale Area (Figure 3.3.9-2). Description of the environment and wildlife is discussed in Section 3.3.9.8.

3.3.10. Environmental Justice

Environmental justice is defined as "The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.” Fair treatment means that “no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies" (EPA, 2014a).

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, was signed on February 11, 1994, by President William J. Clinton to focus Federal attention on the environmental and human health conditions of minority and low-income populations. The goal of Executive Order 12898 is to achieve environmental protection for all communities. The Executive Order directs each Federal agency to consider environmental justice part of its mission. Its intent is to promote fair treatment of people of all races and incomes, so that no person or group of people shoulders a disproportionate burden of the negative environmental effects from this country's domestic and foreign programs. Specifically, the Executive Order requires an evaluation in the EIS as to whether the proposed project would have disproportionately high and adverse human health and environmental effects on a minority population, a low income population, or Indian tribe (CEQ, 1997a). In this Draft EIS, BOEM equates high adverse effects with severe and thus major adverse effects.

Since 1999, all BOEM public meetings have been conducted under the auspices of environmental justice, and presentations on Executive Order 12898 and how BOEM is addressing it have been made at scoping meetings and government-to-government consultations. Environmental justice-related concerns are incorporated into environmental study planning and design, environmental impact evaluation, and the development of new mitigation measures for incorporation into the EIS.

Environmental justice concerns were solicited in the Cook Inlet region during government-to-government meetings with the Seldovia Village Tribe in Seldovia on November 12, 2014, with the Port Graham Tribal Council via teleconference on November 24, 2014, and with the Nanwalek Village Tribe in Anchorage on December 1, 2014. Concerns expressed at these meetings included:

- A call for the deferral of all subsistence areas of all Cook Inlet tribes
- Concern that the areas deferred in the description of the proposed Lease Sale Area from Lease Sale 191 were old or limited; and
- Alaska Native Tribes encouraged BOEM to utilize current subsistence and scientific data when considering Lease Sale boundaries

Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50% or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or some other appropriate reference population (CEQ, 1997).

The Alaska statewide population is approximately 20% American Indian and Alaska Native (ADLWD, 2016); for the Kenai Peninsula Borough, the American Indian and Alaska Native population is approximately 7% (ADLWD, 2015). There is variation in ethnic characteristics when looking at individual communities in the proposed Lease Sale Area (Table 3.3.10-1).

Table 3.3.10-1. Population Data for Environmental Justice Communities near the Proposed Lease Sale Area.

Town	Total Population	American Indian and Alaska Native	Percent American Indian and Alaska Native
Port Graham	177	126	71.2
Seldovia Village	165	43	26.1
Nanwalek	254	227	89.4
Ninilchik	883	136	15.4
Chignik Bay	91	52	57.1
Chignik Lagoon	78	49	62.8
Chignik Lake	73	69	94.5
Perryville	113	108	95.5
Ivanof Bay	7	7	100
Akhiok	71	36	50.7
Karluk	37	35	94.5
Larsen Bay	87	62	71.2
Old Harbor	218	191	87.6
Ouzinkie	161	128	79.5
Port Lions	194	114	58.7
Tyonek	171	151	88.3

Source: USCB, 2010.

The potentially affected communities in Table 3.3.10-1 have a meaningfully higher percentage of Alaska Native peoples living in them than the Kenai Peninsula Borough as a whole, and all but one, Ninilchik, have a meaningfully higher percentage of Alaska Native peoples living in them than the state of Alaska as a whole. Moreover, for all but two of these communities, the minority population exceeds 50% of the total community population. Given the percentage of American Indian and Alaska Natives in the communities of Port Graham, Seldovia, Nanwalek, Ninilchik, Chignik Bay, Chignik Lagoon, Chignik Lake, Perryville, Ivanof Bay, Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, Port Lions, and Tyonek, these communities qualify as environmental justice communities. Low income commonly correlates with Alaska Native subsistence-based communities in coastal and rural Alaska; however, these communities qualify as environmental justice communities based on their racial/ethnic minority composition alone.

Consumption of and dependence on fish and wildlife resources for subsistence varies across the communities in and near the proposed Lease Sale Area. In environmental justice analyses, Federal agencies are directed to consider minority populations and Indian tribes with differential patterns of subsistence consumption of fish and wildlife because any high and adverse environmental effects to fish and wildlife from a proposed action could disproportionately impact those communities or populations that depend most on those resources (e.g., contaninants in foods)(CEQ, 1997). The villages in Table 3.3.10-1 display disproportionately high consumption patterns of fish and wildlife and other subsistence resources (see Sections 3.3.3.5 and 3.3.4.3, Tables 3.3.4-2 and 3.3.4-5).

3.4. Oil and Gas and Related Infrastructure

3.4.1. Pipelines and Production and Processing Facilities

The Cook Inlet basin contains commercially significant deposits of oil and gas. Recent assessments by the USGS estimate that the Cook Inlet region contain 637 Bcf of natural gas, 600 MMbbl of oil, and 46 MMbbl of natural gas liquids (Schenk and Nelson, 2015). Oil and gas are produced both onshore and offshore on state lands in the region; however, there are currently no Federal leases in Cook Inlet. On state lands north of the Cook Inlet Program Area, there are 17 offshore oil and gas production platforms (Cook Inlet Facility Assessment, March 26, 2013). A brief history of the discovery of oil and gas in Cook Inlet, and the subsequent exploration and development is provided in Section 2.4.2. Recent and ongoing oil and gas activities in Alaska state waters and on state lands are described in Section 5.1. Cook Inlet Planning Area has several hundred miles of undersea and onshore oil and gas pipelines in state waters and on state lands, respectively. Locations of pipelines and other oil and gas infrastructure in Cook Inlet are described in Section 5.1.

Cook Inlet region crude oil production from both offshore and onshore wells is handled through the Trading Bay Production Facility located on the western side of Cook Inlet. The Trading Bay Production Facility pipelines the produced crude oil it receives from onshore and offshore pipelines to either the Drift River Terminal Facility, or directly to the Christy Lee Tanker Loading Facility, located just offshore of the Drift River Terminal. Since 1996, all Drift River tanker loadings are transported to the Tesoro Refinery, north of the city of Kenai in Nikiski. The Tesoro Refinery, which is one of five active refineries in Alaska (U.S. Energy Information Agency, January 2015), can process up to 72,000 barrels per day (bpd). The refinery produces ultra-low sulfur gasoline, jet fuel, ultra-low sulfur diesel, heating oil, heavy fuel oils, propane, and asphalt. Crude oil is delivered to the Tesoro Refinery by double-hulled tankers coming from the North Slope, or from the Christy Lee tanker loading facility. Additional crude oil is transported to the refinery via the Cook Inlet and Kenai Peninsula pipelines. A 111-km (69-mi), 48,000 bpd common-carrier products pipeline transports jet fuel, gasoline, and diesel from the Tesoro Refinery to the Port of Anchorage and the Anchorage International Airport.

Delta Western is building a new refined oil storage facility at the Port of Anchorage. The first products shipped from this facility will be methanol for use in North Slope oil fields.

Natural gas discoveries in the Cook Inlet basin in the 1950s and early 1960s, combined with a developing export market to Japan resulted in the siting and construction of the largest liquefied natural gas plant in the world in Nikiski on the Kenai Peninsula. A shortage of natural gas in Cook Inlet, combined with the expiration of the LNG plant's export license in March of 2013 resulted in the plant closing after 47 years of continuous operation. Since that time, new discoveries of natural gas in the Cook Inlet Basin, together with a favorable export market, have resulted in Conoco Phillips applying for a new export license. This license was granted in April of 2014 by the U.S. Department of Energy, allowing the export of the equivalent of 40 Bcf of LNG over a two-year period.

Cook Inlet also has Alaska's first underground commercial natural gas storage facility. Cook Inlet Natural Gas Storage of Alaska (CINGSA) constructed and began operating five underground horizontal wells with a storage capacity of 11 Bcf of gas in December of 2011, with future underground storage expansion potential to 17 Bcf.

Cook Inlet produced gas is consumed by a variety of users, both in Alaska and abroad. Natural gas produced in the Kenai Gas Field is shipped via pipeline to Anchorage and to Girdwood for local consumption. The Beluga River power plant uses gas that is produced at the Beluga River field. Additionally, gas from this field is transported by pipeline to Anchorage for local consumption. Gas is also provided to Palmer, Houston, and towns to the south of Soldotna (ADNR, 2009b, Chapter 6). Several proposals currently exist to transport additional LNG out of Anchorage into interior Alaska area, as well as to transport LNG that is produced on the North Slope by pipeline to Anchorage. All of these proposed projects could significantly alter the natural gas infrastructure currently existing in and around the Cook Inlet Planning Area.

In addition to the oil and gas pipeline infrastructure in the Cook Inlet Planning Area, several submarine telecommunications cables run from Anchorage through much of the lower Cook Inlet and also from the Kenai Peninsula across Cook Inlet to Illiamna Bay which traverses the Cook Inlet Program Area. Figure 3.4.1-1 provides a map of the Cook Inlet submarine telecommunications cables.

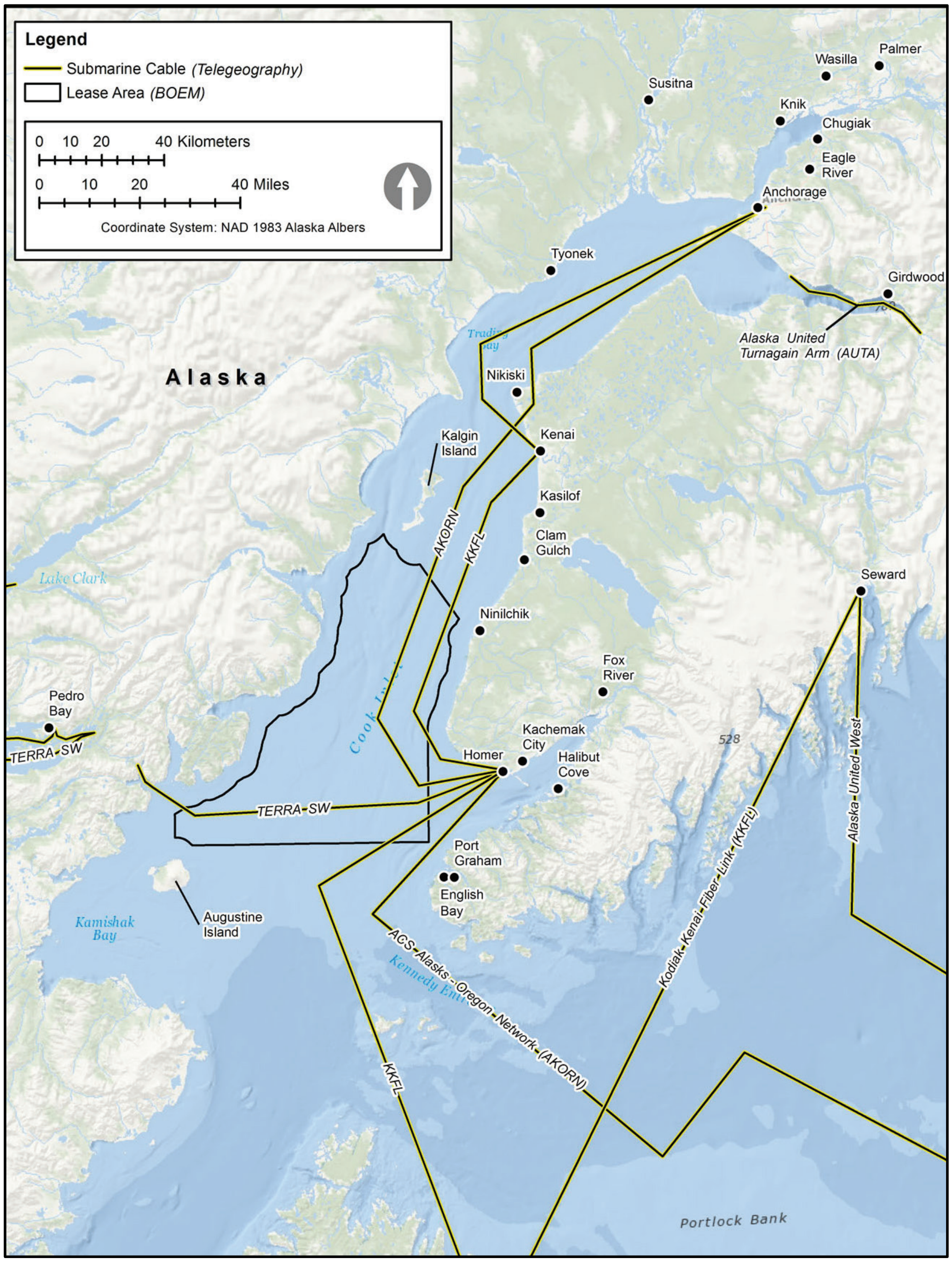


Figure 3.4.1-1. Location of Subsea Cable Routes and the Surrounding Communities.
Source: TeleGeography.

3.4.2. Air-Support Infrastructure

The proposed Lease Sale Area is served by three airports capable of handling cargo and passenger aircraft. The airports are located in Kenai, Soldotna, and Homer (see Figure 3.4.2-1).

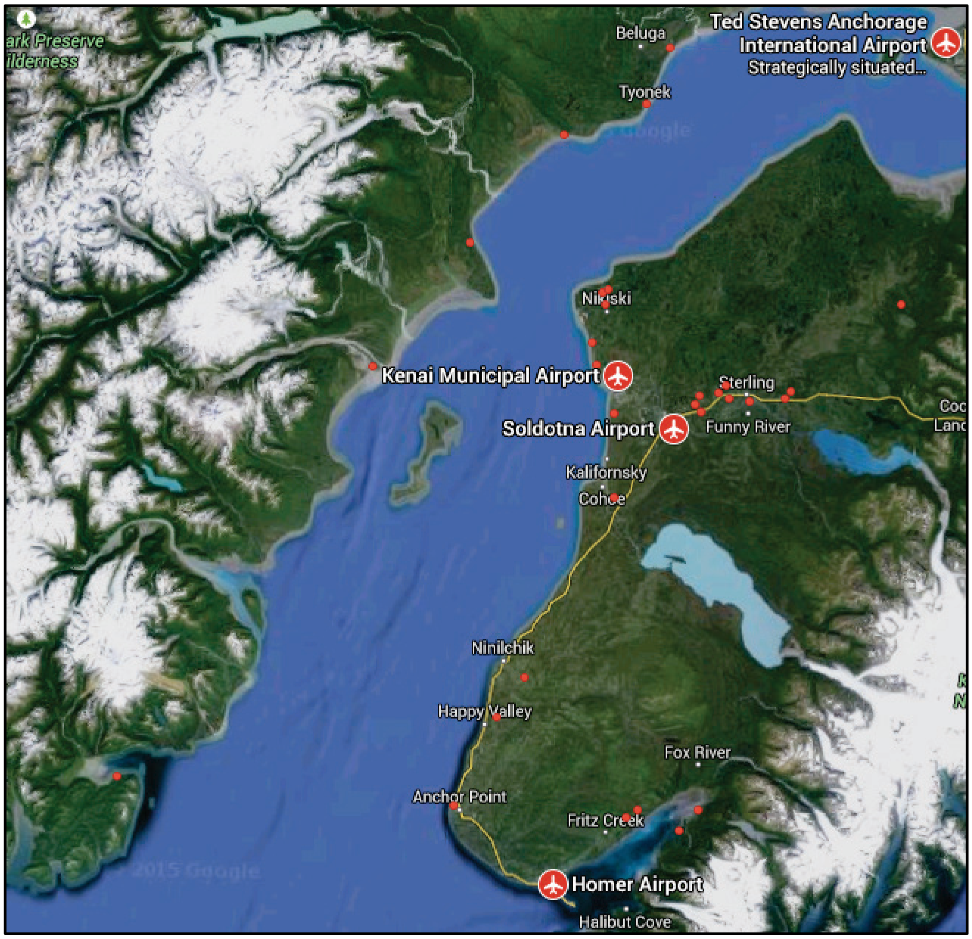


Figure 3.4.2-1. Airports near the Proposed Lease Sale Area. *Source: Google Maps***.**

3.4.3. Marine Transportation

The Port of Anchorage is the third largest port in Alaska, after Valdez and Nikiski. The port was ranked as the 90th largest port in the U.S. in terms of cargo volume with 2.8 million tons of cargo handled in 2012 (American Association of Port Authorities (AAPA), 2012). The port serves as Alaska's regional port (and as a USDoD National Strategic Port), and provides services to approximately 75% of the total population of Alaska, including its five military bases. To support >20 customers, the Port of Anchorage has three dry cargo berths, two petroleum handling facilities, and one barge berth. In 2013, five tankers called on the Port of Anchorage, offloading 4.2 MMbbl of fuel to the port from domestic and foreign petroleum suppliers. In 2014, fifteen fuel tankers called on the Port of Anchorage, resulting in a 59% increase in fuel delivered when compared to 2013. Fuel arriving by tanker or barge into the city docks is offloaded on two dedicated petroleum docks. In addition to oil tankers and barges, general cargo and dry bulk vessels, cruise ships also routinely call on the Port of Anchorage. The port generally is limited to the use of barges and small container ships because of its shallow water depths and extreme tidal variations. The port also serves as a staging and fabrication site for modules that are shipped to the North Slope for use in oil and gas activities.

On the western side of Cook Inlet, the only major marine facility lies in Redoubt Bay off of the mouth of the Drift River. The Drift River Terminal Facility consists of a large tank farm and an offshore loading platform where ships dock to take on oil. Oil is pumped to the tank farm via a submerged pipeline which connects the tank farm with the oil fields on the western side of Cook Inlet. Oil tankers load crude from the tank farm using an offshore platform located approximately 5 km (3 mi) offshore, known as the Christy Lee Platform. Crude oil is then transported to refineries.

Two ports are located on the eastern side of Cook Inlet, the Port of Homer and the Port of Nikiski. The Port of Homer is situated 375 km road miles (233 mi) from Anchorage in the Kachemak Bay. The port consists of a deep draft dock and anchorage, a Pioneer dock which receives the state ferry, an ice plant and fish dock, and a small boat harbor with boat ramp (Marine Exchange of Alaska (MEA), 2015). The Port of Nikiski consists of three deep draft docks, plus docks for tugs, drilling rig tenders, and offshore supply vessels. The port is associated with the Nikiski oil and gas terminal located outside the town of Nikiski. The Port of Nikiski is the second largest port in Alaska, after Valdez, and was ranked as the 80th largest port in the United States in 2012 based on cargo tonnage (AAPA, 2012).

Figure 3.4.3-1 shows a summary of Cook Inlet vessel traffic by vessel type.

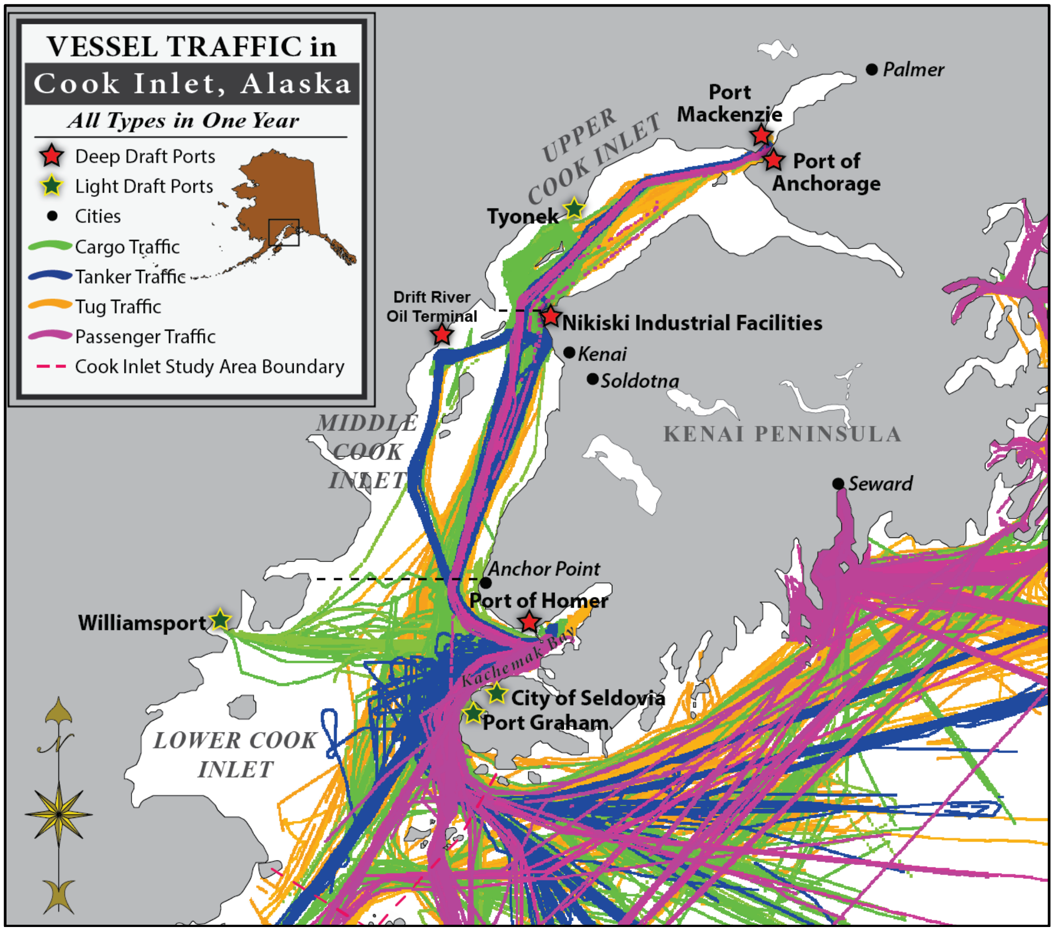


Figure 3.4.3-1. Summary of Cook Inlet Vessel Traffic by Vessel Type. *Source: Cape International, Inc. (2012).*

Of the 480 ships of >300 gross tons entering Cook Inlet in 2010, 218 were destined for the Port of Anchorage, 86 went to the Nikiski oil and gas terminals, and 123 moved through Kachemak Bay (Cape International Inc., 2012). According to a Cook Inlet Vessel Traffic Study done in 2012 by Cape International, Inc. the following vessel transit patterns were found for Cook Inlet:

- Deep draft vessels generally transited along the eastern side of Cook Inlet.
- Tanker ships occasionally transited east to west and back between the Port of Nikiski and the Drift River Terminal Facility.

- Oil service vessels accounted for most of the large vessel activity outside of the traditional north-south transit lines due to the servicing of oil and gas production platforms. In addition, these vessels' tracks frequently intersected the north-south transit lines.
- Eighty percent of large ship operations were made by only 15 vessels that regularly called at Homer, Nikiski, or Anchorage.
- Kachemak Bay had the highest level of traffic activity in Cook Inlet with most large ships entering the mouth of the bay to pick up a marine pilot or await Coast Guard inspection.
- Kachemak Bay was a frequent and preferred port of refuge for ships and tugs while waiting out bad weather.
- Vessel traffic was very consistent throughout the year along the Forelands.
- Shelikof Strait on the western entrance to Cook Inlet was used less frequently by large vessels.

Chapter 4

Environmental Consequences

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Chapter 4. ENVIRONMENTAL CONSEQUENCES

4.1. Introduction

This chapter analyzes the environmental, social, and economic impacts that could occur as a result of the exploration, development, production, and decommissioning activities associated with Lease Sale 244. The following alternatives, previously described in Section 2.2, are evaluated:

- Alternative 1 – The Proposed Action
- Alternative 2 – No Action
- Alternatives 3A, 3B, and 3C – Beluga Whale Critical Habitat Exclusion or Mitigation/Nearshore Feeding Areas Mitigation
- Alternatives 4A and 4B – Northern Sea Otter Critical Habitat Exclusion or Mitigation
- Alternative 5 – Gillnet Fishery Landscape Mitigation Area
- Alternative 6 – Prohibition of Drilling Discharges

The Proposed Action is analyzed first and in greatest detail because it includes the entire proposed Lease Sale Area and encompasses all of the OCS oil and gas activities estimated to occur as a result of Lease Sale 244. Each action alternative is analyzed in comparison to the Proposed Action. The analysis of the No Action alternative is required by NEPA regulations (40 CFR 1502.14).

BOEM created an exploration, development, production, and decommissioning scenario (the E&D Scenario) that estimates the various activities that may occur as a result of Lease Sale 244. The E&D Scenario's estimates, for the levels of oil and gas activities, are based on a 40-year period. The activities associated with the E&D Scenario are described in Section 2.4.

4.1.1. 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 judgement 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 Draft EIS 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 example, 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 BOEM and other Federal agencies in their NEPA analyses of other proposed Federal actions. Examples include the approaches set forth in the Final Programmatic EIS for the Atlantic OCS Proposed Geological and Geophysical Activities (USDOI, BOEM, 2014); 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).

The impact analysis includes routine activities and accidents. Routine activities are all of the planned activities included in the E&D Scenario (Section 2.4). An accident is an unplanned event or sequence of events that results in an undesirable consequence. In this analysis, the undesirable consequence is an oil spill or gas release in the environment. The analysis distinguishes between small spills and a large spill or gas release:

- **Small spills** – accidental oil spills that are <1,000 bbl. BOEM considers two general oil types for small spills: crude and refined oil. BOEM estimates a total of 460 (rounded to nearest ten) small crude or refined oil spills over the life of the E&D Scenario (Appendix A).
- **Large spill** – an accidental oil spill that is ≥1,000 bbl. BOEM estimates the chance of no large spill occurring is 78%, and the chance of one or more large spills occurring is 22% over the life of the E&D Scenario (Appendix A). Although unlikely, each “large spill” impact determination is based on the assumption that a large spill occurs.
- **Gas release** – BOEM also assumes that up to one well control incident of a single well could occur, releasing 8 MMcf of natural gas in one day (Appendix A). A gas release was included in the analysis, but a separate impact-scale determination was not made for a gas release because the impacts are estimated to be no greater than those for a large spill for any resource.

4.1.2. Analyzing Potential Impacts at the Lease Sale Stage

A lease sale stage is the second of BOEM’s four-stage process (Five Year Program, Lease Sale, Exploration, and Development and Production) as outlined in the OCSLA and summarized in Chapter 1. The Lease Sale EIS document identifies and analyzes potential impacts from stages three (Exploration), four (Development and Production), and beyond (Decommissioning). Operators are required to submit an EP prior to stage three exploration activities, and a DPP prior to stage four development of production infrastructure. A separate NEPA analysis will be conducted by BOEM for each stage prior to issuing permits to operators to commence activities. Operators also must submit an Application for Permit to Drill for any well to BSEE, and receive BSEE’s approval that regulations at 30 CFR 250 and 30 CFR 254 are met. These regulations require the owner/operator to submit an OSRP to demonstrate spill response capability, as well as comply with government initiated unannounced exercises (GIUE, or oil spill drills), to demonstrate they have well-maintained emergency response equipment. Impact analyses in this chapter are as specific and quantitative as possible given the 40-year projected time frame of activities in the E&D Scenario.

4.2. Impact-Producing Factors for Routine Activities

Oil and gas activities listed in the E&D Scenario have the potential to affect resources. Based on the E&D Scenario, this section identifies and discusses the IPFs for routine activities associated with the Proposed Action. Table 4.2-1 summarizes the screening of relevant IPFs for each resource. Relevant IPFs also are briefly identified in each resource-specific subsection in Chapter 3. IPFs associated with Lease Sale 244 activities are summarized in Table 4.2-2.

Table 4.2-1. Impact Matrix.

Resources	Seafloor Disturbance and Habitat Alteration	Drilling Discharges	Other Operational Discharges	Water Intake	Noise: Active Acoustic Sound Sources	Noise: Drilling and Equipment Noise	Noise: Vessel Noise	Air Pollutant and Greenhouse Gas Emissions	Physical Presence, Including Lights	Trash and Debris (Including Non-hazardous Domestic Waste)	Vessel Traffic	Aircraft Traffic and Noise	Cuttings Transport and Disposal	Onshore Support Activities	Employment and Project Spending	Accidental Oil Spills and Gas Release
Air Quality								X			X	X		X		X
Water Quality	X	X	X							X						X
Acoustic Environment					X	X	X					X				X
Lower Trophic Level Organisms	X	X	X	X					X							X
Fish and Shellfish	X	X	X	X	X	X	X		X	X						X
Marine Mammals	X	X			X	X	X		X	X	X	X				X
Terrestrial Mammals	X								X			X		X		X
Birds		X			X				X	X	X	X		X		X
Coastal and Estuarine Habitats			X							X	X			X		X
Economy and Population															X	X
Commercial Fishing	X				X	X	X		X	X	X					X
Subsistence Harvest Patterns	X	X	X		X	X	X		X	X	X	X	X	X		X
Sociocultural Systems														X	X	X
Public and Community Health								X							X	X
Recreation, Tourism, and Visual Resources									X	X	X	X	X	X		X
Sport Fishing	X				X	X					X					X
Archaeological and Historic Resources	X	X							X							X
Areas of Special Concern			X					X	X			X				X
Oil and Gas and Related Infrastructure	X															X

X = indicates a potential impact

Table 4.2-2. Impact Producing Factors Associated with E&D Scenario Phases.

Impact-Producing Factor		E&D Phase: Exploration: Seismic Surveys	E&D Phase: Exploration: Exploration and Delineation Drilling	E&D Phase: Development	E&D Phase: Production	E&D Phase: Decommissioning
Seafloor Disturbance and Habitat Alteration		--	X	X	--	X
Drilling Discharges		--	X	X	--	--
Other Operational Discharges		X	X	X	X	X
Water Intake		--	X	X	--	--
Noise	Active Acoustic Sound Sources	X	X	X	X	--
Noise	Drilling and Equipment Noise	X	X	X	X	X
Noise	Aircraft Traffic and Noise	X	X	X	X	X

Impact-Producing Factor	E&D Phase				
	Exploration		Development	Production	Decommissioning
	Seismic Surveys	Exploration and Delineation Drilling			
Vessel Noise	X	X	X	X	X
Air Pollutant Emissions	X	X	X	X	X
Physical Presence, Including Lights	X	X	X	X	X
Trash and Debris Including Non-Hazardous Domestic Waste)	X	X	X	--	X
Vessel Traffic	X	X	X	X	X
Cuttings Transport and Disposal	--	--	X	-	-
Onshore Support Activities	X	X	X	X	X
Employment and Project Spending	X	X	X	X	X
Accidental Oil Spills or Gas Release	X	X	X	X	X

X = indicates a potential impact; -- indicates no impact expected.

4.2.1. Seafloor Disturbance and Habitat Alteration

Seafloor disturbance and habitat alteration in the Proposed Action will result from drilling wells and placement of anchors, nodes, cables, sensors, pipelines, and other equipment on the seafloor for completion of various activities described in the E&D Scenario. Based on expected water depths in the proposed Lease Sale Area and recent exploration activities in the state waters of Cook Inlet, it is likely that a jack-up rig or an anchored drillship will be employed for exploration drilling. The seafloor will be disturbed by placement and removal of drilling rig legs on a jack-up rig, or by placement of anchors from a drillship and installation of production platforms that would be used for development well drilling. OCS blocks where surveys or exploration drilling would be conducted could be anywhere within the proposed Lease Sale Area.

The E&D Scenario estimates 7 to 10 exploration and delineation wells would be drilled. The total area of disturbed sediment due to jack-up rig legs would depend on rig design, diameters of the legs, and the number of wells drilled by jack-up rigs. According to BOEM (2012a), each set up of a jack-up rig disturbs a seafloor area of approximately 1 ha (2.5 ac). Assuming 10 exploration and delineation wells will be drilled with a jack-up rig, a total of approximately 10 ha (25 ac) of seafloor could be disturbed as a result of potential jack-up rig placement activities resulting from the Proposed Action.

Anchoring causes physical compaction of the seafloor beneath the anchor, and when chains or lines move, they can disturb the bottom and resuspend sediment. A disturbed area on the seafloor called an “anchor sweep” forms by the swing arc of anchor lines scraping across the bottom within the range allowed by the anchoring system configuration (USDOI, BOEM, 2012a) that would be required for anchored drillships. Anchored drillships disturb approximately 2 to 3 ha (5 to 7 ac) of seafloor at each wellsite, depending on the number of anchors and their mooring configurations (USDOI, BOEM, 2012a). Assuming 10 wells are drilled with an anchored drillship, a total of 20 to 30 ha (50 to 75 ac) of seafloor could be disturbed as a result of anchoring activities resulting from the Proposed Action. The total area of seafloor disturbance from drilling of exploration or delineation wells will depend on the number of wells drilled from jack-up platforms as opposed to anchored drillships.

The E&D Scenario assumes that 2 to 3 production platforms will be installed in the Cook Inlet OCS. All development wells will reach the surface at the production platforms. It also is assumed that each production platform will be a steel-caisson platform, designed to be resistant to tides and ice. Total area of sediment disturbed by use of a steel-caisson platform will depend on platform design. The 2012 Leasing Programmatic EIS estimates each production platform will disturb approximately 1.5 ha (3.7 ac) of seafloor (USDOI, BOEM, 2012a). No additional area of surface disturbance from drilling multiple development wells from production platforms is expected.

BOEM expects subsea pipelines to be constructed to transport produced oil and gas from an offshore platform serving as a hub for the other 1 or 2 platforms to the nearest landfall location, likely between Homer and Nikiski. Additional subsea pipelines would be constructed to connect the other platforms to the hub platform. It is not expected that discoveries as a result of the Proposed Action will be able to utilize existing offshore pipelines. The primary pipelines carrying oil and gas from the offshore hub platform are expected to have a 0.3 m (12-in.) diameter, trenched into the seafloor at least 1 m (3 ft) below the mudline, where sediments allow (30 CFR 250.1003(a)(1)). If trenching is not possible due to unsuitable sediments, anchors may be used to provide stability to the pipeline to resist strong tidal movements. Pipeline construction is expected to occur between May and September. The E&D Scenario identifies the potential for two pipelines to shore to be constructed along the same corridor, one for oil and one for gas.

Seafloor disturbance as a result of pipeline construction, trenching, or associated anchors would depend on the final length of the pipelines and whether trenching occurs. It is estimated that placement disturbs between 0.5 and 1 ha (1.25 and 2.5 ac) of seafloor per kilometer of pipeline, with the uncertainty depending on whether trenching is required (Cranswick, 2001). BOEM estimated that the total length of the offshore oil pipelines will range 96 to 137 km (60 to 85 mi), and the total length of the offshore gas pipelines will range from 96 to 185 km (60 to 115 mi), depending on the actual platform and landfall locations. For the total potential pipeline length of 322 km (200 mi), it is estimated that 161 to 322 ha (398 to 796 ac) of seafloor could be disturbed, depending on the amount of trenched and buried pipe. It is not expected that pipelines will be removed at the end of their serviceable life; rather, they will be decommissioned and buried in sediment. This practice prevents the additional disturbance to sediments and benthic communities which would occur if pipelines were removed.

Pursuant to NTL 2005-A03, BOEM/BSEE will require site-specific information regarding potential archaeological resources and sensitive benthic communities prior to approving any activities involving seafloor-disturbing activities, or placement of bottom-founded equipment or structures in the Cook Inlet Planning Area. BOEM will use this information to ensure avoidance of physical impacts to archaeological resources or sensitive benthic communities.

4.2.2. Drilling Discharges

During exploratory drilling, drilling fluids and drill cuttings may be discharged, disperse in the water column, and accumulate on the seafloor (National Research Council (NRC), 1983; Neff, 1987; Neff, 2010). An NPDES permit must be obtained from the EPA in order to discharge drilling fluids. EPA Region 10 maintains jurisdiction over the areas comprising the proposed Lease Sale Area, and issues all NPDES permits for facilities operating outside but adjacent to state waters. The NPDES General Permit AKG-28-5100 NPDES authorization is for certain oil and gas activities in the OCS. The General Permit has made the determination that the discharges will not result in an unreasonable degradation of the marine environment (EPA, 2015a,b).The General Permit allows for discharges of drilling fluids and drill cuttings during exploration drilling, but does not authorize discharges during development and production drilling from new sources (facilities that initiated the process of development or production on or after the date of promulgation of the New Source Performance Standards (March 4, 1993; see 58 *FR* 12454, January 15, 1993)). BOEM produced the E&D Scenario based on the assumption that all drilling discharges from development and production wells would be reused, reinjected, or shipped to shore.

During the initial stages of drilling, seawater is used to jet a large cellar into the soft sediments on the seafloor. After the conductor pipe is set, the well is drilled to the surface casing setting depth, which will be above any oil or gas zone. After the surface casing is cemented in the hole, a Blow Out Preventer (BOP) is installed on the top of the surface casing to prevent water and hydrocarbons from escaping into the environment in the event of a loss of well control. Once the BOP is fully tested, the next section of the well is drilled. The marine drilling riser is a pipe with special fittings that connects the top of the wellbore and the drilling rig. After it is set, all drilling fluids and cuttings are returned to the drilling rig and passed through a solids control system designed to remove cuttings and silt so drilling fluids may be recirculated downhole. Drill cuttings are typically sand or gravel sized rocks. They may be discharged into the water via the shale chute, barged to land for disposal, or ground up and reinjected into a disposal well drilled from a platform for that purpose.

Drilling fluids in widespread use are water-based fluids (WBFs) or synthetic-based fluids (SBFs). Typically, the sections of wells above the surface casing setting depth are drilled with WBF, while lower intermediate and production sections are drilled with SBF (USDOI, BOEM, 2012a). In well intervals where WBF systems are used, spent WBF, WBF-wetted cuttings, and adsorbed solids are discharged to the ocean at a rate of 0.2 to 2.0 m^3/hour (Neff, 1987). Overboard discharge of these materials results in increased turbidity in the water column, alteration of sediment characteristics, and elevated concentrations of some trace metals (NRC, 1983; Neff, 1987). In shallow environments, WBFs disperse rapidly in the water column and particulates quickly descend to the seafloor immediately after discharge, causing periodic minor increases in turbidity (Neff, 2010); in deeper water, fluids discharged at the sea surface are dispersed over a wider area (Neff, 1987).

SBF is costly, so drillers have strong financial incentives, as well as regulatory obligations, to preserve and recycle it. When spent drilling fluid and cuttings are returned to the drilling rig floor, they are put into shale shakers to separate the cuttings from the drilling fluid. The cuttings are then rinsed to remove additional SBF. The SBF is reconditioned and used to continue drilling that well. When it is practical, an operator will reuse SBF to drill subsequent wells. Retention on cuttings would be subject to regulatory limits; for example, under the final NPDES General Permit AKG 28-5100 permit for EPA Region 10 in Cook Inlet, the limits are 6.9% for internal olefins and 9.4% for esters (EPA, 2015a). When discharged at the sea surface in the absence of swift bottom currents, SBF-wetted cuttings typically settle close to the discharge point affecting sediments and benthic invertebrates in proximity (Neff, McKelvie, and Ayers, 2000; Continental Shelf Associates, Inc., 2006).

The E&D Scenario assumes 435 tons of drilling fluids and 747 tons of dry rock cuttings per exploration and delineation well will be discharged to the seafloor around the wellsite. In high-energy environments such as Cook Inlet, little of the drilling fluids and cuttings are expected to accumulate near wellsites because deposits are quickly transported away by strong currents (Hannah and Drozdowski, 2005). Consequently, WBFs and cutting solids could be dispersed over large areas in low concentrations, depending on the dynamics proximal to the discharge (Neff, 2010). In areas without strong bottom currents, WBFs and cuttings solids typically are concentrated within 500 m (820 ft) of the seafloor discharge location (Continental Shelf Associates, 2004). Discharge of WBFs and cuttings solids may cause localized smothering of benthic organisms and changes in sediment grain size within a 500-m (1,640-ft) radius affecting an area of 78.5 ha/well (194 ac/well). The total area of seafloor affected by drilling discharges from exploration and delineation drilling will depend on the number of wells drilled, water depth, and local hydrodynamics.

The E&D Scenario assumes drilling 7 to 10 exploration and delineation wells and 55 to 66 production wells. Assuming 10 exploration and delineation wells, the total amount of material discharged to the seafloor could be 3,045 to 4,350 tons of drilling fluids, and 5,229 to 7,470 tons of rock cuttings from exploration and delineation drilling. These estimates assume the normal practice of drilling exploration wells substantially deeper than the target formation.

Drilling of development wells will be similar to drilling of exploration and delineation wells except that SBF-wetted cuttings and SBF from development wells cannot be discharged overboard and instead will be shipped to shore for disposal or reinjected into approved disposal wells. BOEM estimates the average development well will produce approximately 839 tons of dry rock cuttings. No drilling fluids or cuttings will be discharged at production wellsites (see Section 4.2.11).

4.2.3. Other Operational Discharges

An NPDES permit must be obtained from the EPA in order to discharge into the ocean any effluent that may be associated with well drilling and field development and operations. Not including drilling discharges, the major waste discharges produced during exploration and development drilling include bilge water, ballast water, fire control system test water, cooling water, sanitary and domestic wastes, and deck drainage (USDOI, BOEM, 2012a). Other discharges that could occur during exploration drilling include desalination unit discharges, BOP fluids, boiler blowdown discharges, excess cement slurry, several fluids used in subsea production, and uncontaminated freshwater and saltwater (USDOI, BOEM, 2012a). Water used for hydrotesting may be discharged during construction and commissioning of oil and gas pipelines. The aforementioned discharges are covered under the final General Permit AKG-28-5100 and the administratively extended General Permit AKG 31-5000. The discharge of development and production facility outputs, including drilling fluids, cuttings, produced water, produced sand, and well treatment and completion fluids, are prohibited.

Bilge water collects in the lowest part of a ship; it may be contaminated by oil that leaks from the machinery within the vessel and is required to be processed through an oil-water separator prior to discharge. The discharge of any oil or oily mixtures having oil >15 parts per million (ppm) is prohibited under 33 CFR 151.10. Ballast water is used to maintain the stability of the vessel. Generally, ballast water is pumped into and out of separate compartments and is not contaminated with oil. In March 2012, the USCG issued Ballast Water Discharge Standards enumerating the requirements for the management of ballast water (33 CFR 151(D). These changes are included in the EPA's Final 2013 Vessel General Permit and the Draft 2013 small Vessel General Permit (sVGP).

All vessels with toilet facilities must have Type II or Type III marine sanitation devices (MSDs) that comply with 40 CFR 140 and 33 CFR 159 for sanitary wastes. A Type II MSD macerates waste solids so that the discharge contains <150 mg/L of suspended solids and a bacteria count <200 per 100 milliliters (mL). Type III MSDs are more commonly used systems designed to retain or treat the sanitary waste until it can be disposed of at proper onshore facilities. State and local governments regulate domestic and gray water discharges that consist of materials discharged from sinks, showers, laundries, safety showers, eyewash stations, hand-wash stations, and galleys. Gray water discharges are not regulated outside the state's territory.

Fire control system test water is seawater used to operate fire control equipment and pumps, or used as a barrier between flaring systems and personnel or equipment. This water typically is discharged directly to the ocean with no treatment following guidelines in the NPDES permit. Cooling water is seawater used to cool equipment on rigs or vessels; see Section 4.2.4 for further discussion on cooling water intake. Deck drainage includes wastewater from all operational surfaces on drilling rigs, platforms, and vessels. The NPDES permit requires deck drainage to contain no free oil. Rainwater and other water falling on contaminated areas of drilling rigs or platforms will pass through an oil-water separator prior to discharge.

Produced water and sand are extracted with oil or gas from hydrocarbon-bearing strata and can contain formation water, injection water, treatment and completion fluids, and high levels of dissolved solids and minerals (USDOI, BOEM, 2012a). The extended 2007 General Permit AKG 31-5000 prohibits discharge in new production areas of produced water and sand during development drilling or production activities. Discharges associated with exploration drilling such as well treatment, workover, or completion fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater are subject to guidelines and stipulations in the relevant NPDES permit.

BOEM expects that support vessels will make 1 to 2 trips per week during seismic surveys (which could last for 3 years), 1 to 3 trips per week during the E&D Scenario phases (which could last for 4 and 7 years, respectively), and 1 to 2 trips per week during the production phase (which could last for up to 33 years). Based on these estimated durations of activities in the proposed Lease Sale Area, discharges could occur during 156 to 312 support vessel trips during seismic surveys; 208 to 624 support vessel trips during the exploration phase; 364 to 1,092 support vessel trips during the development phase; and 1,716 to 3,432 support vessel trips per platform during the production operations over a 33-year period. Vessel traffic during decommissioning activities will depend on the scope of activities to be completed. Assuming that 76 wells are drilled and 30 to 60 days are required to drill each well, drilling rigs could be present in the proposed Lease Sale Area for approximately 2,280 to 4,560 days, during which time the rigs would be discharging effluents covered under a NPDES permit.

4.2.4. Water Intake

Seawater will be drawn for once-through, non-contact cooling of machinery on the drilling rigs. Fish, larvae, and other marine life can become trapped at the screen at the entrance to the cooling water intake and may become impinged, entrained, or killed. Section 316(b) of the CWA requires NPDES permits to ensure that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available to minimize adverse environmental impacts from impingement and entrainment of aquatic organisms. The current NPDES permit for oil and gas activities in Cook Inlet incorporates these regulations, including requirements for intake water velocity to be <0.2 m/s (0.5 ft/s), construction to minimize impingement and entrainment, accurate entrainment record keeping, and a biological study of source water.

The E&D Scenario assumes that up to 76 wells will be drilled in the proposed Lease Sale Area, with each well requiring 30 to 60 days to drill. Additional cooling water withdrawal could occur during the production phase. Withdrawal amounts during production would depend on number and types of offshore structures requiring cooling water intakes. Seawater may be withdrawn to fill pipelines during construction or hydrotesting.

4.2.5. Noise

Impacts to acoustic habitat will depend on the sound sources introduced, their temporal and spatial characteristics, environmental conditions, and the extent of current development in the basin (i.e., existing background noise). Acoustic habitat will be affected by high-intensity, short-term noise as well as an increase in “chronic” noise over the long-term life of the field. Often, multiple phases of development occur at the same time with certain activities dominating discrete time periods. High-intensity but short-term noise from seismic marine geophysical surveys and drilling will predominate in the exploration phase. Conversely, vessel activity and production noise are long-term, low-frequency sources with vessel noise expected in all phases and production noise during the production phase. A summary of noise source characteristics can be found in Table 4.2.5-1. Sound level measurements of noise sources are typically expressed as root mean square (rms) sound pressure levels (SPLs). Some impulsive sources may be expressed as peak to peak (p-p) or zero to peak (0-p). Within this document, all measurements are expressed as rms unless otherwise noted. Primary sources of noise most likely to affect acoustic habitat quality considered for OCS energy development are briefly described here:

1. Seismic sources typically have a sound level of 200 to 230 dB re 1 μPa @ 1 m, with maximum energy between 10 Hz and 10 kHz (DECC, 2011).
2. Vessel noise dominates the low-frequency bands and has a maximum sound level that ranges between approximately 160 to 220 dB re 1 μPa @ 1 m with maximum energy between 10 Hz to 1 kHz and a steep negative slope above 80 Hz (Hildebrand, 2009; NRC, 2003a).
3. Drilling unit sound source levels during drilling can have sound levels that range from 90 dB re 1 μPa within 50 km (31 mi) of the drilling unit to 138 dB re 1 μPa within a distance of 0.01 km (0.06 mi) from the drilling unit (Greene 1985, 1987b). Sound levels associated with drilling activities that include drilling and station-keeping (thruster) operations average approximately 190 to 195 dB re 1μ Pa @ 1 m with maximum energy between 10 Hz and 10 kHz (DECC, 2012; Hildebrand, 2009).
4. Production platform sound is less well defined in the literature and varies depending on platform type. Mean production sound levels are composed of continuous low-frequency sound >120 dB re 1μPa @

1 m. Measurements of sound from individual platforms are variable. One platform generated broadband sound at 162 dB re 1 µPa @ 1 m (DECC, 2011). Production activities at an artificial island production facility measured between 81 and 141 dB re 1µPa @ 550 m (Wyatt, 2008). A platform within Cook Inlet measured 119 dB re 1µPa @ 1.2 km (Blackwell and Greene, 2003).

Oil and gas fields are fairly well developed in Cook Inlet state waters and several acoustic studies have been performed in the basin. There have been 13 exploration wells drilled within the Cook Inlet OCS, with up to 10 more exploration wells to be drilled and 2 seismic surveys estimated to be conducted under the Proposed Action. There will be an increase in ambient noise within underwater habitat, and to a lesser extent, above water habitat. Although noise from vessels, aircraft, seismic surveys, drilling, and production will cross multiple phases of the development process, the specific temporal and spatial characteristics of the acoustic habitat will depend greatly on the phase of exploration and development.

Table 4.2.5-1. Cook Inlet Development SPLs for Selected Sources and Operational Activities.

Source Type	Primary Amplitude Frequency Range[1](Hz)	Representative Source Levels at 1 m[2] (dB re 1 µPa)	Reference[3]	Primary Development Phases for Activity[4]
Supply & Support Vessels	20 – 1,000	120 - 200	1, 2, 8,11	1 - 9
Ice-Handling Vessels	<500	177 - 193	5	1 - 9 (regionally)
Tug & Barges	<5,000	171	1, 11	1 - 9
Submerged Deep-well Pumps	Unknown	>120	10	4, 5, 6, 8
Site Surveys:				2, 3, 7, 9
Single/Multibeam Echosounder	12,000 - 18,000 and up to 240,000	220	1	
Side-Scan Sonar	400,000 - 900,000	215	6	
High-Resolution Subbottom Profiler	2,000 – 24,000	210	6	
Low Resolution Subbottom Profiler	1,000 – 2,000	212	6	
Fixed & Rotary Winged Aircraft	<1,000	110 - 134	3, 6, 11	1 - 8
Conductor Pipe & Pile Driving	100 - 500	250 (p-p)	4, 5, 9, 10	7, 8, 9
Seismic Surveys:				
Towed Airgun Arrays	5 - 300	230 – 260	3, 4, 7, 8, 11	1
Ocean Bottom Cable and Node Acoustical Positioning (or Pinger) System	35,000 - 55,000	184 – 197 (p-p)	7, 8	1
Vertical Seismic Profile Surveys	<500	225 - 228	7, 10	1, 6
Streamer Positioning (on vessel hull, source floats, streamers, and tail buoys)	10,000 - 100,000	195 (p-p)	7	1
Drilling	400	184	4, 5, 11	1
Jack-Up Platform (Drilling)	2 – 1,400	140	12	1,2
Jack-Up Platform (Non-drilling)	10 – 1,250	120	13	1,2
Drillships/DP Vessels	<600	190	1, 4, 5	5, 6
Oil & Gas Production Platforms	40 - 100	195	2, 5, 11	8

Notes: [1]All listed sources produce broadband sound. The frequencies listed represent the bandwidths in which the majority of energy is produced.
[2]Representative source levels measured in root mean square (rms) unless noted otherwise.
[3]Sources: (1) McKenna et al., 2012; (2) Greene and Moore, 1995; (3) Richardson et al., 1995; (4) Kyhn, Tougaard, and Sveegaard, 2011; (5) Blackwell and Greene, 2003; (6) NOAA, 2015c; (7) IOGP, 2011; (8) Aerts et al., 2008; (9) USDOI, BOEM, 2015d; (10) NOAA, 2014; (11) Hildebrand, 2004; (12) Marine Acoustics Inc., 2011; (13) Illingworth & Rodkin, Inc., 2014.
[4]Associated Activities: (1) Exploration - Marine Seismic Surveys, (2) Geohazard Surveys, (3) Geotechnical Surveys, (4) Platform Installations, (5) Drilling - Exploration Wells, (6) Oil and Gas Production and Well Service, (7) Pipeline Installations, (8) Production Activities, (9) Associated Infrastructure Construction.

4.2.5.1. Active Acoustic Sound Sources

The E&D Scenario identifies several types of surveys that would utilize active acoustic sound sources, including 2D/3D seismic surveys, OBC and OBN seismic surveys, geohazard surveys, marine CSEM sounding, and gravity surveys. The potential for each of these to be used in Cook Inlet is outlined in the E&D Scenario and is summarized briefly in the following section, with a description of the types of active acoustic sound sources utilized by each survey type.

Marine Seismic Exploration: Seismic data exist for the Cook Inlet Basin as a result of completed oil and gas exploration. BOEM estimates that two seismic surveys would be conducted during the first 2 years of the E&D Scenario. BOEM expects that the most likely type of survey will be a 3D survey to focus on clusters of OCS blocks that have been identified as having a high potential for oil and gas resources based on existing seismic data. It is not expected that regional seismic surveys will be conducted over the entire proposed Lease Sale Area. Additional details regarding seismic surveys are provided in Section 2.4.4.

Geohazard Surveys: These surveys, required before operators submit an EP or DPP, characterize potential geological hazards, document seafloor communities, and identify any potential archaeologically significant resources. Geohazard surveys, conducted in association with a lease, are site-specific and typically do not cover the entire OCS block. The survey area extent depends on the number of potential drillsites on the OCS block and the sea floor surface expression of the proposed wellbore. Additional details about geohazard surveys are presented in Section 2.4.4.

4.2.5.2. Drilling and Equipment Noise

Underwater marine sounds associated with drilling operations include strong tonal components at low frequencies averaging 10 to 500 Hz, and in some cases infrasonic frequencies (Richardson et al., 1995; USDOI, MMS, 2000). Drillships, jack-up rigs, and production platforms can be expected to produce noise from drilling, machinery, and maintenance operations. Sound and vibration from engines, generators, and drilling machinery on board a drillship are transmitted through the hull (Richardson et al., 1995). Marine sounds emitted by drilling rigs were found to be dominated by a mix of tones thought to be related to the drill string rotation rate. When drilling, the drill string represents a long vertical sound source. Piling and conductor pipe (surface casing) driving may occur during drilling and development and can produce broadband impulsive sounds up to 250 dB re 1 μPa @ 1 m (p-p).

Noise levels vary with the type of drilling rig and water depth. Drillships produce the highest levels of underwater noise because the hull containing the rig generators and drilling machinery is well coupled to the water. Based on available data, marine sound generated from drillships during drilling and in the absence of thrusters is expected to range between 154 and 176 dB re 1 μPa @ 1 m (Greene, 1986; Nedwell, Needham, and Edwards, 2001). Use of thrusters by unanchored drillships, whether drilling or not, can elevate sound source levels from a drillship to approximately 188 dB re 1 μPa @ 1 m (Nedwell and Edwards, 2004). The majority of noise from an operational drillship measures in the 40- to 600-Hz band at a range of 0.5 to 2 km (0.3 to 1.2 mi) (Nedwell and Edwards, 2004). Underwater noise from jack-up rigs is expected to be relatively weak because a small surface area of equipment is in contact with the water; most machinery is on the rig deck well above the water surface, and there is no propulsion noise (USDOI, BOEM, 2012a).

Noise associated with activities on production platforms and with pipeline operations varies, and depends on the type and extent of activities. Machinery noise from fixed production platforms can be continuous or transient, with intensities that vary by platform type and water depth. Gales (1982) reported underwater noise from fixed structures varied from approximately 20 to 40 dB above background levels within a 30- to 300-Hz frequency spectrum at a distance up to 30 m (98 ft). Noise transmitted from fixed platforms elevated on metal legs would likely be weak due to the small surface area of the platform in contact with the water (USDOI, BOEM, 2012a).

4.2.5.3. Vessel Noise

Vessel noise is one of the main contributors to noise in the sea (CSA Ocean Sciences Inc., 2014; Gordon and Moscrop, 1996; Normandeau Associates, Inc., 2012; NRC, 2003a). Survey vessels, MODUs, and barges contribute to the overall noise environment by transmitting noise through air and water. Vessel noise is a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995) with tones that typically dominate up to approximately 50 Hz. The majority of broadband sound energy is restricted to frequencies below 100 to 200 Hz, but broadband sounds may include acoustic energy at frequencies as high as 100 kHz. The primary sources of vessel noise are the propeller(s) and machinery. Ship-generated noise at frequencies below 50 Hz is dominated by sound produced by propeller cavitation, which results from high thrust loading and non-uniform inflow of water into a propeller (Okeanos, 2008). Some propellers in service may produce a high-pitched noise, often referred to as propeller singing. This sound usually is a clear harmonic tone within the practical frequency range of 10 to 1,200 Hz, although the audible range of propeller singing can be as high as 12 kHz (HydroComp, Inc., 2003). Primary sources of machinery noise include diesel-powered propulsion engines and ship service engines (Okeanos, 2008). Other sources of noise include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Intensity of noise from service vessels is related to ship size and speed with large ships tending to be noisier than small ones and laden ships producing more noise than unladen vessels. For a given vessel, relative noise tends to increase with increasing speed. Ship noise radiates asymmetrically, with stern aspect noise levels higher than bow aspect levels by 5 to 10 dB (McKenna et al., 2012). Broadband source levels for most small ships, a category that would include seismic survey vessels, are anticipated to be in the range of 170 to 180 dB re 1 µPa @ 1 m (Richardson et al., 1995).

The category and type of vessels operating during development and production will highly depend on the phase of activity. Smaller supply vessels in transit to and from the proposed Lease Sale Area consistently would produce transient sounds in the 128 to 158 dB re 1 µPa @ 1 m range, with predominant low-frequency components <1,000 Hz. If a supply vessel remained on standby, it would produce low continuous sound levels. Larger supply vessels may be required in more open water environments, and these can produce sound levels of 155 to 190 dB re 1 µPa @ 1 m. Specific operations may require special vessels that produce higher sound source levels than supply vessels; however, these sources represent short duration activities with sporadic occurrence. These specific operations include dynamic positioning (DP), pile/conductor driving, and tug/barge activities. DP vessels can produce low-frequency (<600 Hz) amplitudes of 190 dB re 1 µPa @ 1 m. Pile and conductor pipe-driving activities would be associated with larger construction vessels, DP vessels, and barges. Tug and barge activities can produce amplitudes of 171 dB re 1 µPa @ 1 m.

4.2.6. Air Pollutant and Greenhouse Gas Emissions

Construction and implementation of the Proposed Action will produce air emissions from survey vessels, support vessels, drilling rig operations, production platforms, onshore support activities, helicopters, use of light aircraft, and oil spills. Emissions will be mainly from combustion of diesel fuel and aircraft fuel. Well testing during the exploration phase and venting and flaring during the development phase also will result in emissions from combustion. Air emissions may also occur during treatment and disposal of SBF-wetted cuttings. Construction vessels and trucks, forklifts, cranes, and other hauling and lifting equipment used at the dock and onshore base will emit air pollutants. Primary criteria and precursor air pollutants typically associated with OCS activities are particulate matter (fine particles ($PM_{2.5}$)) with an aerodynamic diameter not greater than 2.5 micrometers (µm), and coarse particles (PM_{10}) with an aerodynamic diameter not more than 10 µm, sulfur dioxide (SO_2), including sulfur oxides (SO_x), which are collectively referred to hereafter as SO_2, nitrogen oxides (NO_x), including nitrogen dioxide (NO_2), which are collectively referred to hereafter as NO_x, carbon monoxide (CO), lead, (Pb), volatile organic compounds (VOCs), and ozone (O_3). These pollutants will be generated or, in the case of O_3, formed as a result of air emissions onshore at lease locations in the proposed Lease Sale Area, and along routes from shore bases to OCS leases by vessels and helicopters. Based on the activities proposed under the E&D Scenario, air pollutants will be emitted for a period of 40 years. See Sections 4.2.9 (Vessel Traffic) and 4.2.10 (Aircraft Traffic and Noise) for estimates of the number of potential vessel and helicopter trips that would occur under the E&D Scenario. Greenhouse gases (GHGs), including, but not limited to, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), will contribute to global effects of a changing climate (IPCC, 2014).

It is acknowledged that some portion of the oil and gas produced from Lease Sale 244 leases would be consumed as fuel, which would produce GHG emissions that would also contribute to climate change. However, because end use consumption is not part of the Proposed Action, and because any attempt to quantify a marginal increase in national oil and gas consumption (much less resulting GHG emissions or ensuing environmental effects) attributable to Lease Sale 244 oil and gas would be unduly speculative, this EIS does not attempt to quantitatively analyze or model environmental effects from the end use consumption of produced oil and gas.

4.2.7. Physical Presence, Including Lights

The physical presence of MODUs, platforms, vessels, and pipelines can attract birds, fishes, and other marine life. Fouling organisms will accumulate on MODUs, platforms, and support vessels that act as “artificial reefs.” Pipelines and other subsea structures located above the sediment or seafloor will act similarly. Offshore vessels and structures maintain exterior lighting for navigational and aviation safety in accordance with Federal regulations. Artificial lighting and gas flaring may attract and directly or indirectly impact natural resources, particularly birds.

Light sources on offshore drilling rigs and vessels include navigational lighting, helicopter flight deck lights, and safety and performance lighting for work areas (Golder Associates et al., 2007). Gas flaring is an additional source of light on offshore drilling rigs. Navigational lighting must meet International Convention for Safety of Life at Sea (SOLAS) requirements as per International Maritime Organization (IMO) Resolution MSC.253(83) (IMO, 2007), or equivalent requirements. Helicopter flight decks use perimeter lighting in accordance with international standards such as International Civil Aviation Organization Annex 14, Volume II (Heliports) or American Petroleum Institute (API) Recommended Procedure 2L (Planning, Designing, and Constructing Heliports for Fixed Offshore Platforms). Exterior lighting on drilling rigs and support vessels may be visible from shore, depending on the location of leased OCS blocks, size of offshore structures, atmospheric conditions, and the viewer’s elevation. In good weather, lights on top of an offshore structure approximately 76 m (250 ft) above sea level, such as an oil platform, can be visible to a 2-m (6-ft) tall person at a distance of approximately 38 km (24 mi) (USDOI, BOEM, 2012a). No OCS blocks within the proposed Lease Sale Area are >38 km (24 mi) from the nearest shoreline, and it is likely that any offshore structures in the proposed Lease Sale Area will be visible from land during optimal viewing conditions. Gas flaring and lighting of offshore oil and gas platforms is also highly visible to many nocturnally migrating bird species in the air space above or at oblique angles, often from many miles away (Weise et. al., 2001). Lights and structures on pipelaying barge/vessels and other construction vessels also will be visible from land and potentially attract birds and fishes.

Most activities in the E&D Scenario would be conducted from offshore vessels. The most extensive vessel activities are seismic surveys, which could occur anywhere in the proposed Lease Sale Area. Vessels conducting seismic surveys would operate in clusters of OCS blocks identified in completed regional seismic surveys as having a high potential for commercial hydrocarbons reservoirs, and along potential pipeline routes to shore. The E&D Scenario estimates that one to two seismic surveys, four to five geohazard surveys, and four to five geotechnical surveys may occur as a result of the Proposed Action. The duration of the seismic, geohazard, and geotechnical surveys would depend on survey area and type.

Entanglements of certain species (dolphin, ray, and sea turtle) have occurred in the Gulf of Mexico (GOM) as a result of ocean bottom cable surveys. The USFWS and NMFS are aware of these entanglements and have not deemed entanglement of wildlife to be a serious issue in Alaska. In previously published Biological Opinions and recent Incidental Take Authorizations in Alaska the impacts and likelihood of entanglement were dismissed as too remote to warrant scrutiny (USFWS, 2003; 2007; 2012e; NMFS, 2015f). Furthermore, the avoidance marine mammals and fish typically extend toward seismic surveys, and the use of weighted and semi-rigid lines in seismic surveys further minimizes entanglement risks. By avoiding areas in the vicinity of seismic surveys, marine mammals and fish should not encounter node lines where they could potentially be affected. Semi-rigid lines linking end nodes to buoys would be incapable of flexing to the extent that a marine mammal, fish or bird could become entangled with it. For these reasons, entanglement from seismic surveys is considered to be highly unlikely and not reasonably foreseeable.

Vessels involved in drilling activities would be operating at specific sites consisting of one or more OCS blocks. Drilling operations in Cook Inlet are estimated to take 30 to 60 days per well, depending on the well's target depth, potential delays, and other factors. Assuming that 76 wells are drilled, support vessels associated with drilling could be present in the proposed Lease Sale Area for 2,280 to 4,560 days.

A safety/exclusion zone for drilling rigs, drillships, and platforms will be established. A typical safety/exclusion zone is a 500-m (1,640-ft) radius from which all vessels, including fishing, commercial, and recreational vessels, would be excluded. A safety/exclusion zone for pipelines may also be established.

4.2.8. Trash and Debris (Including Non-Hazardous Domestic Waste)

Offshore operations generate trash comprising paper, plastic, wood, glass, metal, and other materials. Most trash is associated with galley operations. Occasionally, some personal items such as hardhats and personal flotation devices are accidentally lost overboard. The discharge of trash and debris is prohibited (33 CFR 151.51 through 151.77) unless it is passed through a comminutor (a machine that breaks up solids) and can pass through a 25-millimeter (mm) mesh screen. Discharge of plastic is prohibited regardless of size. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste under a Waste Management Plan.

USCG and EPA regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. In addition, over the last several years, companies operating offshore have developed and implemented trash and debris reduction and improved handling practices that have reduced accidental loss of trash and debris.

Under the Proposed Action, all authorizations for offshore activities would include guidance for trash and debris awareness that would be similar to BSEE's NTL 2012-G01 ("Marine Trash and Debris Awareness and Elimination"). All vessel operators, employees, and contractors actively engaged in offshore activities must be briefed on trash and debris awareness and elimination as described in that NTL. An applicant would be required to ensure that its employees and contractors be made aware of the environmental and socioeconomic impacts associated with trash and debris as well as their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment.

4.2.9. Vessel Traffic

All of the vessels involved in offshore oil and gas exploration activities would operate out of shore bases that serve as launching points for the structures, equipment, supplies, and crew. In addition to providing berthing space, fuel, and supplies, the shore bases may provide products and services such as engine repair, electric generators, chains, gears, tools, pumps, compressors, and a variety of other tools and equipment. It is expected that supply vessels will mobilize from shore bases in Kenai, Nikiski, Homer, or Anchorage.

Seismic survey vessels collecting data with one or more towed streamers typically are 60 to 90 m (approximately 200 to 300 ft) long. Three-dimensional seismic surveys usually require larger vessels than 2D seismic surveys because there is more equipment to be towed. Surveys could occur anywhere within the proposed Lease Sale Area, with 24-hour operations that may continue for days, weeks, or months, depending on the size of the survey. The seismic vessels used for an OBN survey typically includes (1) two vessels for node placement/retrieval; (2) one or two source vessels depending on water depth; and (3) one to three smaller (10 to 15 m (33 to 49 ft)) utility boats. The E&D Scenario includes one to two marine seismic surveys, four to five geohazard surveys, and four to five geotechnical surveys. The final number of seismic, geohazard, and geotechnical surveys will vary based on the number of leases and potential wellsites.

Barges may be used to transport spent drilling fluids and rock cuttings from the production wells to an onshore disposal facility once or twice a week. Vessel traffic would occur year-round as the area remains relatively ice-free in the winter. If sea conditions develop that would be unsafe for supply vessels, helicopters would be used for basic resupply and personnel transport.

Supply vessels will be used during exploration seismic surveys, exploratory and production drilling, and production phases of the Proposed Action to deliver supplies and personnel to remote locations in the proposed Lease Sale Area. Based on the E&D Scenario, support vessels will make 1 to 2 trips per week during seismic surveys (which could last for 3 years), 1 to 2 trips per week per MODU during the exploration phase (which could last up to 5 years) and 3 to 6 trips per week during the production phase (which could last up to 33 years). Vessel traffic during decommissioning activities will depend on the scope of activities to be completed.

For safety reasons, survey operators attempt to keep an area (called a stand-off distance) around a source vessel and its towed-streamer arrays clear of other vessel traffic. The size of the stand-off distance varies depending on the array configuration; a typical stand-off distance is approximately 8.5 km (4.6 nmi) long and 1.2 km (0.6 nmi) wide, covering 1,021 ha (2,523 ac) of the sea surface. With the source vessel moving at speeds of approximately 4.5 kn, the length of time that any particular point is within the stand-off distance is approximately 1 hour. Stand-off distances may also be established for supply and construction vessels to ensure safety. A typical stand-off safety/exclusion zone is a 500-m (1,640-ft) radius around all vessels and equipment from which all other vessels, including fishing, commercial, and recreational vessels, would be excluded.

4.2.10. Aircraft Traffic and Noise

During exploration and delineation drilling, helicopters support operations by transporting supplies and personnel. Based on the E&D Scenario, helicopters will make one to three flights per day during exploration drilling with an estimated duration of 4 years from shore bases in Kenai, Nikiski, Homer, or Anchorage. Under this scenario, one to three helicopter flights per day could occur for a maximum of 600 days during the exploration phase.

Based on the E&D Scenario, two to three platforms will be installed in the proposed Lease Sale Area as a result of Lease Sale 244. In this scenario, one to three helicopter flights per day at up to three platforms could occur for the duration of the expected 8 years of development drilling and platform construction. Oil and gas production is estimated to continue for 33 years once all development of the fields is complete. Helicopter flights during this 33-year period would be expected to continue at the frequency of one to three flights per day per platform.

Helicopters and fixed-wing aircraft generate noise from their engines, airframe, and propellers. The dominant tones for both types of aircraft generally are <500 Hz (Richardson et al., 1995). Richardson et al. (1995) reported that received sound levels in water from aircraft flying at an altitude of 152 m (approximately 500 ft) were 109 dB re 1 μPa for a Bell 212 helicopter, and 101 dB re 1 μPa for a small fixed-wing aircraft such as a BN Islander aircraft. Helicopters are approximately 10 dB louder than fixed-wing aircraft of similar size (Richardson et al., 1995). Penetration of aircraft noise into the water is greatest directly below the aircraft; at angles >13° from vertical, much of the sound is reflected and does not penetrate (Richardson et al., 1995). Duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 152 m (approximately 500 ft), audible in air for 4 minutes, may be detectable underwater for 38 seconds at 3 m (10 ft) depth, and 11 seconds at 18 m (59 ft) depth (Richardson et al., 1995). All aircraft would be expected to follow FAA (2004) guidance, which recommends a minimum altitude of 610 m (2,000 ft) when flying over noise-sensitive areas such as national parks, wildlife refuges, and wilderness areas.

4.2.11. Cuttings Transport and Disposal

Based on the E&D Scenario, barges may be used to transport rock cuttings from the production wells to onshore disposal facilities if they are not reinjected offshore. Drilling fluids will be reused or reinjected into disposal wells. Barges may be used to transport drilling fluids and cuttings from exploration areas located in Kamishak Bay, where drilling discharges are prohibited under the Final NPDES General Permit AKG 28-5100. Barges are expected to make one to two trips per week from the drilling locations to a suitable onshore facility. Onshore facilities for disposal of drilling fluid and rock cuttings currently exist as a result of ongoing leases in Alaska state waters, and no new construction of disposal facilities is expected.

Based on information presented in the E&D Scenario, each production and service well may produce approximately 839 tons of rock cuttings. Based on the estimated 55 to 66 production wells possible as a result of Lease Sale 244, a total of 46,145 to 55,176 tons of rock cuttings may be transported by barge for disposal onshore. Cuttings typically are transported in metal containers known as cuttings boxes or skips that have a capacity of 4 to 8 tons of material (Morris and Seaton, 2006). Production drilling could last up to 7 years and would require 528-1056 barge trips assuming 1 to 2 barge trips per week. Barge trips between development well locations and onshore disposal sites also would produce air emissions (see Section 4.2.6), and potentially be associated with IPFs based on the barges' physical presence (see Section 4.2.7), and traffic (see Section 4.2.9).

4.2.12. Onshore Support Activities

The E&D Scenario estimates that shore base activities associated with the Proposed Action would occur over a 40-year period and would be located in Kenai or Nikiski, or at alternate locations such as Homer or Anchorage. Cook Inlet has been producing oil and gas from Alaska state waters since the 1960s. As a result, existing onshore infrastructure is well developed and can accommodate hydrocarbon exploration and production activities from the Proposed Action, with limited land use changes. Approximately 11 hectares (~28 acres) of wetlands, including stream crossings, would be excavated and then backfilled to accommodate the construction of the two buried pipelines. Pipeline construction would also disturb approximately 61hectares (~151 acres) of upland. The entire 72 hectares (~179 acres) of construction would be through wetlands and uplands that were previously disturbed by the construction of existing pipelines. All vessel and helicopter support activities would utilize shore bases, as described in Sections 4.2.9 and 4.2.10.

Non-hazardous domestic waste produced from offshore rigs, platforms, and vessels will be transported to shore bases and delivered to approved landfills for final disposal. The total volume of domestic waste that will be produced during the life of the E&D Scenario will depend on the number of wells drilled and total levels of activities that occur. All hazardous waste, radioactive waste, and drilling fluids and cuttings will be manifested and disposed of at approved facilities under a Waste Management Plan.

4.2.13. Employment and Project Spending

Based on the estimated level of activities resulting from the Proposed Action, direct employment and earnings, increased tax income for state and Federal taxing authorities, and population growth would occur. Employment would vary with the phases of the E&D Scenario. During the exploration phase, seismic surveys (including geohazard and geotechnical work), and exploration and delineation drilling, jobs could be created by operators and contractors. During the development phase, platform installation, development drilling, and pipeline construction would be the primary sources of employment. Employment during decommissioning would be limited to workers removing out-of-use infrastructure. It is estimated that employment would peak in year 6 with 230 jobs created during onshore and offshore pipeline construction. By year 14, all drilling would be completed and the platforms, pipelines, and other facilities would be solely in production mode. Thus, drilling would no longer contribute to direct employment. During production, it is estimated that 53 direct annual jobs would be created (Owl Ridge Natural Resource Consultants, 2015).[1]

Estimated direct earnings would depend on wages and the total number of jobs created. Based on local wage data, the average wage for oil and gas industry employment in the Kenai Peninsula Borough in 2011 was $98,445 (McDowell Group, 2013), or approximately $109,000 in 2015 dollars. Direct earnings are estimated to peak at approximately $25 million in year 6 during the employment maximum and drop to approximately $6 million per year during oil and gas production (Owl Ridge Natural Resource Consultants, 2015).

During the production phase there would be platform and shore-based employment to produce oil and gas. Indirect employment and revenue would also be generated through the value of goods and services purchased by workers and the retail and wholesale jobs created when the workers spend money on other products in the economy. The indirect and induced employment and earnings are estimated through the USDOC, Bureau of Economic Analysis (BEA), Regional Input-Output Modeling System (RIMS II) multipliers. Regional input-output multipliers are based on a set of detailed industry accounts that measure the goods and services produced by each industry and the use of these goods and services by final users (McDowell Group, 2013). Specifics about the multipliers are discussed in Owl Ridge Natural Resource Consultants, Inc. (2015). Based on these multipliers, the amount of indirect and induced employment is estimated to reach a maximum of 427 jobs in year 6 and remain at 99 jobs during production in years 14 to 40. Indirect and induced earnings are likewise estimated to peak in year 6 at $35 million and remain at $9 million per year during production (Owl Ridge Natural Resource Consultants, 2015).

Taxes and royalties will be generated by the Proposed Action and will be split by Federal and state taxing authorities. Because development will occur in Federal waters, the State of Alaska will receive 27% of bonus bid, rental, and royalty revenues from leases within 4.8 km (3 mi) of the edge of state waters but none of the Federal revenues from other leases.[2] The Kenai Peninsula Borough will not receive bonus bids, royalties, or production or state corporate income taxes, but will receive property taxes for pipelines or other infrastructure on Kenai Peninsula Borough land. It is estimated that over the life of the project,

[1] For the purposes of this EIS, employment estimates are limited to jobs for Kenai Peninsula Borough. The vast majority of Alaska employment resulting from the Proposed Action would be in other parts of Alaska, generally in the greater Anchorage area. Estimates for BOEM's internal regional economic impact model, MAG-PLAN Alaska, are developed with a different methodology. They also are usually reported for the entire state and would therefore be much larger.

[2] Section 8(g) of the OCSLA requires this sharing of Federal revenues from leases in those waters extending 3 mi seaward of the edge of state waters. This "8(g) zone" is 3 to 6 mi from shore for Alaska.

the Kenai Peninsula Borough would receive $8 million, and the State of Alaska would receive $27 million (2015 dollars). Federal revenues would stem from royalties and corporate income taxes. Total royalties are projected to be $3.6 billion and total estimated income taxes are $7.2 billion (2015 dollars) (Owl Ridge Natural Resource Consultants, 2015).

4.2.14. Accidental Oil Spills and Gas Release

Stakeholders have expressed concern about the potential for oil and gas exploration, development, production or decommissioning activities to release or spill hydrocarbons into the environment. Accidental gas releases or 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, 2011; USEIA, 2015).

This section summarizes technical information from the E&D Scenario and Appendix A to create a set of assumptions for purposes of environmental effects analysis of the Proposed Action or its alternatives. The background information from which these assumptions are derived is provided in Appendix A.

This Draft EIS analyzes the effects of accidental oil spills, which will not necessarily occur under the Proposed Action or its alternatives, but have varying potential to occur. They are discussed in this section as IPFs. As shown in Tables 4.2-1 and 4.2-2, accidental oil spills or gas releases have the potential to affect all resources during all or particular phases of the E&D Scenario (i.e., exploration, development, production, and decommissioning), depending on the spill type, source, and size (volume). The assumptions were developed using technical information and historic data (detailed in Appendix A), as well as lease sale and 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 or releases either estimated or assumed to occur during the different phases.

4.2.14.1. Small Oil Spills (<1,000 bbl)

Small spills, although accidental, have occurred with generally routine frequency and are considered likely to occur from exploration, development, production or decommissioning activities. The majority of small spills would be contained on a vessel or platform, and refined spills that reach the water would evaporate and disperse within hours to a few days. Further, those spills reaching the water have some potential to 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 Proposed Action or its alternatives.

4.2.14.1.1. Summary of Assumptions about Small Spills

BOEM bases the analysis of effects from small oil spills for the Proposed Action or its alternatives on the assumptions in Table 4.2.14-1. BOEM estimates about 460 small spills would occur over the course of the 40-years of the E&D Scenario. These estimated small spills are totaled and rounded to the nearest ten. Details are further discussed below and in Appendix A.

Table 4.2.14-1. Small Spill Assumptions.

Variable	Assumption for Purposes of Analysis
Number of Spills	460 total – Rounded to nearest ten
Activities	Small refined oil spills occur during geological and geophysical activities, exploration and delineation drilling activities, and development, production and decommissioning 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. Small refined and crude oil spills during development and production could occur any time of the year.
Sizes	Geological and geophysical activities: most would be 0 up to <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 (432) would be 3 gallons; 16 would be 3 bbl and two would be 126 bbl.

Variable	Assumption for Purposes of Analysis
Medium Potentially Affected	• production facility and then the water or ice • open water • broken ice • on top of or under solid ice • shoreline • snow
Weathering	50 bbl spill evaporates and disperses within 3 days. Spills of <1 bbl evaporate and disperse within 6-24 hours.

Exploration

Small refined oil spills may occur during Exploration (5 years; Year 1 through 5). The estimated total and annual number and volume of small refined oil spills during exploration activities is displayed in Table 4.2.14-2. BOEM estimates about 10 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 estimated 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 geological, geophysical and drilling activities for the equipment and refueling.

Table 4.2.14-2. Total and Annual Potential Small Oil Spills for Identified Activities.

Activity Phase	Estimated Total Number	Estimated Total Volume (bbl)	Average Annual Number	Average Annual Volume (bbl)
Exploration	**Small Refined Oil Spills**			
Exploration Geological and Geophysical Activities	0 – 6	0 – <18	0 – 2	0 – <1 or <13
Exploration and Delineation Drilling	0 – 4	0 - 65	0 – 1	0 – ≤5 or ≤50
Development and Production	**Small Crude, Liquid Natural Gas Condensate or Refined Oil Spills**			
Development, Production, Decommissioning	0 – 450	0 – 310	0 – 13	0 – 9
Total	**0 – 460**	**~400**	**n/a**	**n/a**

Note: Table represents the estimated to number and volume of small spills by total and annual average for the time period of the identified oil and gas activities. Na = not applicable

Development and Production

Crude, condensate, or refined small oil spills may occur during development, production, and decommissioning. About 450 small crude and refined spills could occur during development and production. The majority of small spills are likely to occur during the 33-year crude or condensate oil-production period (Year 8 through 39), which is an average of about 13 spills per year or a little over one per month.

4.2.14.2. Large Oil Spill (≥1,000 bbl)/Gas Release

A large spill is a statistically unlikely event. Based on the Oil-Spill Risk Analysis (OSRA) data summarized in Appendix A, the mean spill number of large spills, over the entire life of the Proposed Action or its alternatives, is less than one (0.24 (about one quarter of a large spill)) and the most likely number is zero. There is a 78% chance of no large spills occurring and a 22% chance of one or more large spills occurring over the life of the Proposed Action and its alternatives. The statistical distribution of large spills shows that it is much more likely that no large spills occur than one or more over the life of the Proposed Action or its alternatives. However, because large spills are an important concern, and no one can estimate the future perfectly, BOEM assumes a large spill occurs and conducts a large oil spill analysis for the development and production activities. This “what if” analysis addresses whether such spills could cause serious environmental harm and informs the decision maker of potential impacts should an unlikely large spill occur. Assuming a number of large spills or gas releases that is higher than the most likely number of spills helps to ensure that this Draft EIS does not underestimate potential environmental effects.

One large spill of crude, condensate, or refined oil is assumed to occur during the development and production phase. 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). The mean number of large spills is calculated by multiplying the spill rate from Anderson, Mayes, and Labelle (2012) by the estimated resources produced (0.215 Bbbl). By adding the mean number of large spills from platforms and wells (0.05) and from pipelines (0.19), a mean total of 0.24 large spills were calculated for the Proposed Action or its alternatives. Based on the mean spill number, a Poisson distribution indicates there is a 78% chance of no large spills occurring over the 40 years of the Scenario, and a 22% chance of one or more large spills occurring over the same period. The most likely number of large spills is zero.

Up to one large gas release is assumed to occur during the development and production phase. BOEM's analysis of a gas release described in Appendix A evaluates the potential for a large gas release during natural gas development and production of 517 Bcf over 33 years.

The analysis assumed that one well control incident of a single well on the facility would occur, releasing 8 MMcf of natural gas in one day. This is based on the average well production for one day from one well and the estimated rates of blowout duration for gas production wells. The mean number of gas releases over the life of the Proposed Action is less than one (0.04). There is a 96% chance of no large gas releases and a 4% chance of one or more gas releases over the life of the Proposed Action and its alternatives.

For the purpose of the analysis, BOEM assumes that one large spill or gas release would occur during the Proposed Action or its Alternatives. The assumptions BOEM uses to analyze the potential effects of large crude, condensate, or refined oil spill or gas release that could occur from development and production, are set forth in Table 4.2.14-3. The analysis of the potential effects from a large spill or gas release is contained in Section 4.3.

Table 4.2.14-3. Large Spill/Gas Release Assumptions.

Variable	Assumption for Purposes of Analysis
Number of Spills/Release	1 large spill or gas release occurring during the 33 years of oil and gas development and production from either a platform/well or offshore pipeline or onshore pipeline
Percent Chance of One or More Occurring	78% Chance No Large Spills Occurring; 22% Chance of One or More Large Spills Occurring; 96% Chance of No Gas Release Occurring, 4% Chance of a Gas Release Occurring
Activities	A large oil spill or gas release occurs during development or production. No large spill or gas release occurs during geological and geophysical activities, exploration and delineation drilling activities or decommissioning activities.
Timing	A large spill or gas release occur any time of the year. Large crude, condensate, or diesel spills or gas release could occur during the 33 years of crude oil or natural gas liquid condensate production. Large diesel spills could also occur during sales gas production.
Sizes and Oil/Gas Type	Offshore Pipeline 1,700 bbl crude oil or Onshore Pipeline 2,500 bbl crude oil or Platform 5,100 bbl crude, diesel or condensate oil or Platform/Well 8 MMcf of natural gas
Medium Potentially Affected	production facility and then open water, ice or atmosphere open water broken ice on top of or under solid ice shoreline 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: 16-37% evaporates, 19-80% disperses, and 3-61% remains.
Chance of Large Spill Contacting and Timing	Assuming a large spill occurs, the time to contact and chance of contact from a large oil spill are calculated from an oil-spill-trajectory model (Conditional Probability; Appendix A, Tables A.2-1 through A.2-61). The chance of contact is summarized from the location where it is highest when evaluating impacts.
Chance of One or More Large 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 (Combined Probability; Appendix A, Tables A.2-61 through A.2-64).
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.

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 120,000 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 major. In Section 4.12, 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.

Oil-Spill Risk Analysis

For each resource presented in Section 4.3, potential impacts of a large oil spill or gas release are discussed. The analysis of a potential large spill also considers the OSRA results. For resources in Table 4.2.14-4, data table summaries in Section 4.3 represent the highest chance of contact assuming a large spill occurs to resources or resource habitats from any of the six hypothetical launch areas or four hypothetical pipelines. By reporting only the highest percent chance of contact, the range of all possible values is not shown; only the highest value is shown. Combined probabilities, which factor in the chance of one or more large spills occurring, are also discussed for each resource listed in Table 4.2.14-4 in the text. Full discussion and the results are provided in Appendix A. Within the regional OSRA study area (shown in Appendix A, Map A-1), BOEM defines the following resource areas in Appendix A, Sections A-3.1.3 and A-3.1.4:

- Environmental Resource Area (ERA) – Polygons representing areas of social, economic, or biological resources or resource habitat areas
- Land Segment (LS) – Coastline of Cook Inlet, Kodiak, Alaska Peninsula, and the Gulf of Alaska divided into 112 LSs
- Grouped Land Segment (GLS) – Some LSs added together to form larger geographic or resource areas

A particular resource may be described by one or all of these features (e.g., sea otters and birds are expressed using ERAs, LSs, and GLSs), as summarized in Table 4.2.14-4.

Table 4.2.14-4. Resources Described in BOEM'S Oil-Spill Risk Analysis

General Resource	Table (Appendix A)	ERA	LS	GLS
Birds	Table A.1-7	X	X	X
Marine Mammals (Whales)	Table A.1-8	X		
Marine Mammals (Seals and Sea Lions)	Table A.1-9	X		
Marine Mammals (Sea Otters)	Table A.1-10	X	X	X
Subsistence Resources	Table A.1-11	X		X
Anadromous Fish	Table A.1-12		X	
Lower Trophic Level Organisms	Table A.1-13	X		X
Terrestrial Mammals	Table A.1-14			X
Parks and Special Use Areas	Table A.1-15		X	X

4.2.14.3. Opportunities for Intervention and Spill Response

In the event of an accidental oil spill, response operations could occur that may result in a reduction of the spread of spilled oil, thereby potentially decreasing the environmental effects of the spill. These potential mitigating factors are described in this section but not factored into the oil-spill trajectory analysis. Potential environmental impacts from the oil spill response activities themselves are analyzed in Section 4.3. Oil spill response methods and activities are not mutually exclusive, and several techniques may be employed contemporaneously. The availability and effectiveness of each technique may vary with environmental conditions and oil characteristics. For example, offshore intervention activities may be hampered during winter months by low temperatures, the presence of ice, unfavorable seas and weather, darkness, and other factors.

- Mechanical Recovery – Physical removal of oil from the sea surface, typically accomplished using containment booms and skimmers. Booms would be deployed on the sea surface and positioned within or around an oil slick to contain and concentrate the oil into a pool thick enough to permit collection by a skimmer. The recovered oil would be transferred to a storage vessel (e.g., barge or tanker) and subsequently transferred to shore for appropriate recycling or disposal.
- Dispersants – Chemical dispersants are a combination of solvents and surfactants that are applied to oil to promote the dispersion process and form smaller droplets. Smaller droplets may then remain submerged rather than rising to the sea surface, spreading, and potentially contacting land. Dispersion into smaller droplets results in greater surface areas available for microbial degradation and eventually dissolution. Dispersant use is generally limited to waters >10 m (33 ft) in depth and requires an application plan and a monitoring plan in order to obtain approval for use from the Federal On-Scene Coordinator (FOSC) in consultation with the EPA, DOI, DOC, and State of Alaska. Dispersants may be aerially applied using low-flying aircraft (i.e., aircraft flying <46 m (150 ft) above the sea surface) or offshore vessels. Dispersants also may be applied directly at the subsea source of the release using an ROV. The use of dispersants in the presence of cold water and ice is discussed in the Final Second Supplemental EIS for Lease Sale 193 (USDOI, BOEM, 2015e; Section 4.4.2.2.8).
- *In Situ* Burning – Intentional ignition of floating oil at the sea surface is conducted to enhance volatilization of the lighter compounds in oil. Burning causes temperatures to increase at the sea surface as well as temporary air quality issues, and generates residues that may float or sink.

BSEE government-initiated unannounced exercises (GIUEs) or other spill response practices are considered part of the Proposed Action. These activities could include oil spill response equipment deployment, vessels and aircraft traffic, unmanned aerial surveillance, and personnel or vehicle movement. There is some potential for a small refined spill during a spill response or exercise. An exercise is estimated to last less than one day, and may include a tabletop exercise (TTX) to test the operator's incident management team or field deployments of listed spill response equipment to demonstrate equipment and personnel readiness.

4.3. Alternative 1 – The Proposed Action

The Proposed Action, as described in Chapter 2 and detailed in the E&D Scenario provided in Section 2.4, is to offer for lease 224 OCS blocks in the northern portion of the Federal waters of Cook Inlet (Figure 1-1). The proposed Lease Sale Area covers approximately 442,875 ha (1.09 million ac), representing approximately 20% of the total Cook Inlet Planning Area. For the purpose of this analysis, the Proposed Action assumes that the detailed E&D Scenario would occur. The subsections below describe potential impacts of the Proposed Action by resource.

4.3.1. Air Quality

The following subsections describe the potential impacts to air quality from IPFs (emissions sources) associated with the Proposed Action that could affect air quality. The emissions sources relevant to air quality impacts under the Proposed Action are (1) propulsion and auxiliary engines operated onboard vessels, (2) drilling operations, (3) platform operations, including flaring, (4) helicopters and light aircraft, (5) use of above-ground pipelines, (6) construction (onshore and offshore), and (7) accidental oil spills and gas releases.

4.3.1.1. Air Pollutant Emissions

The criteria pollutants whose concentrations are indicative of overall air quality are NO_2, SO_2, CO, Pb, O_3, and PM (PM_{10} and $PM_{2.5}$). These pollutants are federally regulated, and are evaluated for this analysis because of their potentially adverse effects on human health and welfare. In addition, the State of Alaska Department of Environmental Conservation (ADEC) regulates and requires evaluation of emissions of ammonia (NH_3) under the Proposed Action. The precursor pollutant, VOC, is evaluated relative to the contribution to O_3 formation.

Emissions Sources

Engine combustion, in particular from diesel-powered engines, would be the primary source of air emissions associated with the Proposed Action. Most of these engines would operate aboard drilling and drilling-support vessels, but also important are emissions due to equipment and vessels associated with the construction of onshore and offshore pipelines. The primary emissions from engines powered by diesel fuel (distillate oil) combustion (like most engines under all phases of the Proposed Action) are NO_x and CO. Behavior of the pollutants will vary depending on whether the source is stationary or mobile, the spatial location of the source relative to land, sea, and air, and the temporal characteristics of the source throughout the Proposed Action. Stationary sources have a mostly steady exhaust from a fixed location, whereas exhaust from mobile sources is relative to the thrust and power rating of each individual engine and is not discharged in a fixed location. Moving sources result in emissions discharged over some distance, with an elongated plume of pollutants expanding horizontally and vertically, diffusing as it is mixes with the surrounding air. It is the effects of dispersion and diffusion that decrease the ground-based impact of emissions as distance from the source increases.

Helicopters and other aircraft create emissions at varying elevations with respect to the ground. Due to dispersion, emissions from aircraft cruising at an altitude higher than 1,500 ft (457 m) above the surface will not influence concentrations measured at the surface (Kadygrov et al., 1999). Therefore, only emissions that occur during landing-takeoff operations (LTOs) would affect air quality.

Vessels are considered mobile sources of emissions when they are underway and their main engines are used for propulsion. However, a vessel or other drilling device associated with the Proposed Action can be considered and function as a stationary source when the vessel is anchored or otherwise attached securely to the seafloor. Other stationary sources associated with the Proposed Action include offshore production platforms and onshore infrastructure. 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 tend to affect the same downwind location continuously, and thus could deteriorate air quality at downwind locations more than mobile sources.

During the first 5 years of the Proposed Action, only exploration activities will occur. Exploration consists of two main activities: (1) G&G surveys, and (2) exploration and delineation well drilling. While each activity has unique operations, they are similar in their emission characteristics, with emissions primarily from diesel engines. Vessels gathering G&G data would follow a path of grid tracks crisscrossing the Cook Inlet OCS. It is assumed that exploration activity would begin in the year following a lease sale, with G&G surveys taking place during years 1 to 3, and exploration and delineation well drilling occurring during years 2 to 5. Emissions would be from seismic survey vessels, and from drilling 7 to 10 exploration and delineation wells. Further details are provided in Section 2.4. When exploration wells are drilled, the main sources of air emissions are piston-driven diesel engines that power the drilling units, and from flaring while testing wells. Emissions also will occur from support vessels during G&G surveys and drilling exploration and delineation wells. The primary pollutant emitted by diesel engines is NO_x. Also generated in the combustion of diesel fuels, though in much smaller quantities, are SO_2, PM_{10}, $PM_{2.5}$ and CO.

In the development phase, platforms and pipelines are installed and production wells are drilled. The highest emissions would occur during construction of platforms during years 7 to 10, drilling of production wells during years 7 to 13, and installation of onshore and offshore pipelines from years 6 to 9. The majority of air emissions are expected to result from piston-driven engines that power the drilling units for production wells and heavy construction equipment used in the construction of pipelines and platforms. In support of the lease sale, it is expected that 2 to 3 offshore platforms will be constructed to drill 55 to 66 production wells and 10 to 12 service wells. Up to 137 km (85 mi) of new offshore oil pipeline, 185 km (115 mi) of new offshore gas pipeline, 80 km (50 mi) of onshore gas pipeline, and 80 km (50 mi) of onshore oil pipeline may be constructed to transport oil and gas to shore. While there may be some expansion or modification to existing port facilities, it is not expected that any major construction activities will occur onshore other than pipeline construction. Other emissions are associated with diesel engines used in barges, tugboats, cranes, and crew and supply vessels supporting construction activities.

In the production phase, during years 7 to 40, the primary emission sources are natural gas turbines and gas reciprocating engines that provide the production platforms with power for pumping oil, gas reinjection, and gas compression. Other pollutant sources include emissions of VOCs from fugitive emission sources, venting, crude oil storage, and crude oil transport activities. SO_2 also is generated during flaring and gas processing, especially on platforms where sour gas (containing significant levels of H_2S, typically ≥4 ppm by volume) is produced. Flaring also can result in emissions of NO_x and VOCs. In addition, there will be 21 to 36 round-trip flights and 3 to 6 round-trip boat sorties every week during the production phase. The projected average annual rate of air emissions is based on the proposed level of activity as described in the E&D Scenario, and is provided in Table 4.3.2-1. These emissions were estimated using emission factors from BOEM's Revised OECM (USDOI, BOEM, 2012c).

Table 4.3.2-1. Projected Average Annual Rate of Air Emissions - Proposed Action

Criteria and Precursor Pollutants	Emissions (short tons per year)
NO_x	44,152
SO_x	8,566
PM_{10}	1,869
$PM_{2.5}$	1,827
CO	12,109
VOCs	2,532
Pb	0.61
NH_3	8.51
Greenhouse Gases	**Emissions (metric tons per year)**
N_2O	3,364
CH_4	1,021,346
CO_2	16,624,793
Total CO_2e	17,649,504

The results of the projected emissions analysis indicate the likelihood that operators proposing plans under this Lease Sale would be required to obtain an air quality permit from the EPA. The EPA establishes a Prevention of Significant Deterioration (PSD) permit program to protect areas of good air quality from new sources of emissions that may deteriorate the air quality by a certain degree. The protected areas are designated as Class I, Class II, and Class III areas, where Class I areas are provided the most stringent protection, particularly when the proposed sources are located with 100 kilometers (km) (62 statute miles (mi.)) of the Class I Area. The Tuxedni Wilderness Area is designated a Class I area under the U.S. National Wildlife Refuge System and is approximately 6 km (3.7 mi) from the nearest point demarcating the boundary of this Lease Sale, and is located on Chisik Island in the Cook Inlet. The remainder of the land areas adjacent to the Cook Inlet is designated as Class II areas (ADEC, 2016c)

Class I and Class II areas are afforded special protection from air pollution, and there are limitations to the amount of pollution a new source may contribute in the areas. Under the PSD rule, if the projected emissions from a plan proposed under this Lease Sale is expected to exceed 250 tons per year for any pollutant, the operator would be required to obtain a PSD permit from the EPA and the U.S. Fish and Wildlife Service (USFWS) would request a review of the proposal to evaluate the analysis and comment on their visibility requirements. Thus, for any plans proposed within the boundaries of the Lease Sale Area would likely require an EPA PSD permit and possibly a favorable review from the USFWS before a plan may be approved. When a permit is required, the operator must perform a dispersion analysis based on the projected emissions. If the predicted pollutant concentrations exceed any of the applicable Class I or Class II increments, further analysis would be required at the direction of the EPA. No permit is required for this pre-lease stage because of the lack of project- and site-specific information. The maximum allowable NAAQS, PSD Class I and Class II increments are shown in Table 4.3.2-2.

Table 4.3.2-2. NAAQS and EPA PSD Increments

Pollutant	Pollutant Concentrations (μg/m^3)		
	NAAQS	PSD Class I Increments	PSD Class II Increments
Annual Avg. NO_2	100	2.5	25
1-Hour	188		
Annual Avg. SO_2		2	20
1-Hour SO_2	196		
24-hour SO_2		5	91
3-hour SO_2	1,300	25	512
8-Hour CO	10,000		
1-Hour CO	40,000		
Annual Avg. PM_{10}		4	17
24-hour PM_{10}	150	8	30
Annual $PM_{2.5}$	12	1	4
24-Hour $PM_{2.5}$	35	2	9

Source: 40 CFR part 50 and 40 CFR § 52.21(c).

Air Dispersion Modeling

The effects of the emissions projected to result from the E&D Scenario were analyzed using the EPA's Offshore and Coastal Dispersion Model (OCD), a straight-line Gaussian plume model recommended by the EPA for modeling short-range transport of air pollutants over water. The geographic location for the emissions sources within the proposed Lease Sale Area was selected to represent the maximum potential impact on the sensitive Class I Area of Tuxedni Wilderness Area and the remaining Class II areas.

The highest, most conservative potential impacts on the Class I and Class II areas were simulated by placing emission sources from the E&D Scenario in the northwestern corner of the proposed Lease Sale Area, approximately 6 km (3.7 mi) from the Tuxedni Wilderness Area. Five years of meteorological data from the National Weather Service station at Homer, Alaska was applied in the OCD model. Upper-air data for the model were obtained from the National Weather Service office for the Anchorage radiosonde site, which is presumed to be reasonably representative of the upper atmosphere characteristics over Homer, Alaska (ADEC, 2015c).

Emissions from exploration drilling ships while secured to the sea floor, and all platform operations, were modeled as stationary point sources. Modeling did not include emissions projected to occur from the operations of vessels continuously underway, such as support vessels traveling across the proposed Lease Sale Area to and from platforms and drilling ships. Vessel and aircraft traffic will most likely occur between the platform and the Kenai Peninsula between Homer and Nikiski, and is not expected to impact the air quality of onshore areas repeatedly in any one location, which does occur is the case of stationary sources.

The maximum concentrations predicted to occur as a result of the exploration and development exploration scenario and found to affect the air quality over the Tuxedni Wilderness Area, other Class II areas, and offshore areas are shown in Table 4.3.2-3. Maximum concentrations predicted in the same areas during the E&D production scenario are shown in Table 4.3.2-4. The emissions of NO_2 and PM_{10} cause concentrations that would exceed the Class I PSD annual NO_2 and 24-hour average PM_{10} increments. None of the Class II increments are exceeded.

Thus the results of dispersion modeling demonstrate the likelihood that an operator proposing a plan under this Lease Sale would be required to obtain a EPA PSD permit for a Class I area and submit their air quality analysis to the USFWS for review.

Table 4.3.2-3 Highest Predicted Concentrations - E&D Exploration Scenario (Years 2 to 13)

Year	Pollutant Concentrations (μg/m³)		
	Offshore	Tuxedni NWR Class I Area	Onshore Class II Areas
Annual Avg. NO_2	6.957	2.450	0.196
Annual Avg. SO_2	0.115	0.040	0.003
Max. 24-hour SO_2	1.614	0.363	0.068
Max. 3-hour SO_2	5.599	1.125	0.462
Annual Avg. PM_{10}	0.823	0.290	0.023
Max 24-hour PM_{10}	11.590	2.608	0.487

Table 4.3.2-4. Highest Predicted Concentrations - E&D Production Scenario (Years 7 to 40)

Year	Offshore	Tuxedni NWR	Onshore
Annual Avg. NO_2	2.959	1.000	0.083
Annual Avg. SO_2	0.003	0.001	0.0001
Max. 24-hour SO_2	0.039	0.009	0.002
Max. 3-hour SO_2	0.137	0.027	0.011
Annual Avg. PM_{10}	0.254	0.090	0.007
Max 24-hour PM_{10}	3.580	0.806	0.150

The Visibility-Screening Model VISCREEN was applied to assess potential impacts to visibility in the Tuxedni Wilderness Area. For an exploration project located 12 km (7.5 mi) away from the Tuxedni Wilderness Area, the model results exceed visibility screening criteria for the situation where wind blows directly from the facility to the observing site, assuming a 1 m/s (3.28 ft/s) wind speed within stable atmospheric conditions. If the screening criteria are exceeded, it indicates the possibility that a plume generated by emissions would be visible by an observer in Tuxedni Wilderness Area. It does not provide a measure of any general visibility effects such as regional haze in the area. It is likely this scenario would occur less than 1% of the time. For distances greater than 50 km (31 mi), the screening criteria were not exceeded and it is presumed a plume would not be visible at that distance.

4.3.1.2. Accidental Oil Spills and Gas Release

Small Oil Spills (<1,000 bbl)

Evaporation of small accidental oil spills would cause temporary localized increases in VOCs. Accidental discharges could be caused by small leaks or spills of oil or diesel fuel from vessels or equipment during transit, minor accidents, or equipment malfunction. Small spills of refined oil such as lube oil, hydraulic oil, gasoline, or diesel fuel would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within the first 24 hours, potentially causing localized air quality degradation in the immediate vicinity of the spill. Ambient hydrocarbon concentrations in the air would be higher than those of a crude oil spill of similar size but would persist for a shorter time. Small spills of crude oil would persist longer in the environment and result in greater air quality impacts than spills of refined products. The impacts at a given location would depend on the size, location, and duration of the spill and meteorological conditions such as wind speed and direction, but would not likely impact onshore air quality. Cleanup and response activities also would have a minor impact by increasing emissions.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. Large spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. Volatile components of the fuel would evaporate within the first 24 hours, potentially causing localized air quality degradation in the immediate vicinity of the spilled oil. Large spills of crude oil will persist longer in the environment and result in greater air quality impacts than spills of refined products.

Evaporation of large accidental oil spills would cause temporary increases in VOC concentrations. Large oil spills could be caused by a leak from an OCS facility or pipeline. Ambient hydrocarbon concentrations would be relatively high and could persist until cleanup efforts were completed. The impacts at a given location would depend on the proximity of the spill to the shore, response and cleanup time, and meteorological conditions such as wind velocity, and could temporarily impact onshore air quality. Cleanup and response activities would also have a minor impact by increasing emissions.

Although unlikely, for purposes of analysis, BOEM estimates that a well control incident involving a single well could result in the release of 8 MMcf of natural gas in one day. A large gas release and ensuing explosion could result in degraded air quality in the immediate vicinity. Blowouts of natural gas condensates that did not burn would be dispersed rapidly at the blowout site; and air quality likely would not be affected, except very near the blowout source.

Oil-spill Risk Analysis

ERAs, LSs or GLSs were used to estimate the extent of a large spill contacting or occurring and contacting within the OSRA study area. The OSRA model estimates that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%. The effect on air quality due to such a spill would be that emissions of VOC due to evaporation of oil on the water. When combined with prior emissions of NO_x, the formation of ozone is possible.

Spill Response Activities

Responding to an accidental oil spill there are three activities that could have an impact on air quality these activities include in-situ burning, mechanical recovery and dispersants.

In-situ Burning

In-situ burning is one potential technique for cleanup and disposal of spilled oil. 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. For small spills, because of the small volume of oil and the quick methods of cleanup that are available, the level of effect on air quality likely would be negligible.

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, would be likely to have a minor effect both offshore and onshore, and although short-lived, could occur over a large area.

Mechanical Recovery

Mechanical recovery 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. As mentioned in Section 4.3.1.1 most mobile emissions including those of vessels participating in recovery operations have a negligible impact to the air quality of any specific ground-based location. The dispersion of emissions from a moving source makes the accumulation of pollutants less of a concern at any specific downwind location with a decrease in pollutant accumulation with increasing distance from the source.

Dispersants

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).

4.3.1.3. Impact Conclusions

Routine activities under the Proposed Action that are expected to have a measurable impact on air quality are: air emissions from vessel traffic, drillships and drill rigs, construction activities, production platforms and other offshore and onshore infrastructures developed for the purpose of supporting offshore oil and gas operations. The emissions of these criteria pollutants from the Proposed Action will increase concentrations to some extent in various locations within the region.

Due to the characteristics of pollutant transport by the wind and movement of sources, emissions from vessels, helicopters, and onshore vehicles associated with the Proposed Action would have a **negligible** impact to the air quality of any specific ground-based location. The dispersion of emissions from a moving source makes the accumulation of pollutants less of a concern at any specific downwind location with a decrease in pollutant accumulation with increasing distance from the source.

Due to permit regulations for stationary sources and the use of emissions control technology or equipment that meets air emissions standards, measurable impacts from stationary sources at the nearest air quality monitoring stations from routine activities are expected to be **minor**.

A portion of Anchorage is a maintenance area for CO emissions and a portion of the City of Eagle River is a maintenance area for PM_{10} emissions. It is not expected that emissions from the Proposed Action would cause or contribute to an exceedance of CO NAAQS considering the distance from the sources. The impact of accidental small oil and gas spills is likely to be **minor** due to the limited geographical and temporal extent of impacts in the area as confined as the Cook Inlet. Impacts due to a large spill on air quality also are likely to be **minor**. Air quality impacts immediately following a large spill would be short-term. Oil spill response practices are described in Section 4.2.14.3. GIUE oil spill drills are not expected to alter impact conclusions for air quality for routine activities or accidental spills because they are infrequent, of short duration, (<8 hours), and utilize existing equipment. The potential effects of oil spill response activities on air quality include a **negligible** impact from mechanical recovery operations, use of dispersants and in situ burning of small spills, and a **minor** impact from in situ burning of large spills.

4.3.2. Water Quality

This section describes how IPFs associated with the Proposed Action could affect water quality. Section 4.2 discusses IPFs that were identified as having the potential to affect resources in and around the proposed Lease Sale Area. IPFs associated with water quality include (1) seafloor disturbance and habitat alteration, (2) drilling discharges, (3) other operational discharges, (4) trash and debris (including non-hazardous domestic waste), and (5) accidental oil spills and gas releases. Accidental hydrocarbon spills, though not considered a routine oil and gas activity, could occur during each phase of operations.

4.3.2.1. Seafloor Disturbance and Habitat Alteration

Routine activities that would disturb the seafloor and alter habitats are described in Section 4.2.1. During the exploration phase such activities would include setting down and raising jack-up rig legs and spud cans, or anchoring drillships and weighing their anchors, drilling upper well intervals, and excavating well cellars. Seafloor disturbance and habitat alteration during the development and production phases would occur during construction or installation of production platforms, drilling of production or service wells, installation of offshore pipelines, and construction of onshore support structures. Seafloor disturbances would occur during decommissioning when infrastructure is removed.

Estimates of the area of seafloor disturbance as a result of activities expected to occur under the Proposed Action are presented in Section 4.2.1. Direct effects of these activities include physical disturbance of the seafloor, habitat alteration, and sediment resuspension. Resuspension would promote increased turbidity in the deeper portion of the water column with limited impact to the upper water column unless drilling were to occur in particularly shallow water. Scouring around structures and anchors could create small, localized turbidity plumes.

Resuspended sand will settle rapidly from the water column, while finer-grained materials will be transported over some distance before settling to the seafloor. Transport distances of finer-grained materials will be a function of the strength of the ambient currents and settling rates of the clasts. Given the strong tidal currents in Cook Inlet, and widespread evidence for sediment winnowing, the areal extent of turbidity increase during seafloor disturbance would be unlikely to approach that associated with input of glacial flour from streams draining into Cook Inlet (Saupe, Gendron, and Dasher, 2005; Segar, 1995). Feely et al. (1980), citing Gatto (1976), noted that plumes in surface waters associated with riverine input of sediment dissipated within a few tidal cycles; it can be inferred that bottom currents would transport and disperse the more dilute fine-grained materials resuspended during program activities on a similar timescale. Surface tidal current speeds up to 3 m/s (6 kn) have been measured in Cook Inlet (Musgrave and Statscewich, 2006). Feely and Massoth (1982) observed resuspension of bottom sediment in Cook Inlet during periods of maximum tidal currents. Based on these current speeds, resuspended sediments would be transported from an impact area rapidly, water quality impacts would be minor and localized, and normal ambient turbidity conditions quickly restored.

4.3.2.2. Drilling Discharges

Drilling discharges introduced to the water column during the exploration phase of Program Activities could impact water quality. Information about the various types and properties of drilling discharges from routine exploration activities is provided in the Ocean Discharge Criteria Evaluation (ODCE) report (EPA, 2013a). Regulations for drilling discharges are described in Section 4.2.2. Drilling discharges from permitted oil and gas exploration facilities in Cook Inlet are expected to comply with all applicable marine water quality criteria developed pursuant to Section 304 of the CWA (EPA, 2013a).

The Region 10 NPDES General Permit AKG 28-5100 covers drilling discharges during exploration activities. Assuming 10 exploration and delineation wells, the total amount of drilling material discharged to the seafloor during the exploration phase would be 4,350 tons of drilling fluids and 7,470 tons of rock cuttings. Without a general permit in place for drilling discharges during production activities, BOEM produced the E&D Scenario based on the assumption that all drilling discharges from development and production activities would be reused, reinjected, or shipped to shore.

Discharge of WBFs and drill cuttings in the surface water layer below 10 m (33 ft) depth would create a plume of suspended material demarcated by elevated turbidity (NRC, 1983; Neff, 1987). Discharge of drilling fluids and drill cuttings near the seafloor would cause increased suspended material in the lower water column, which would eventually settle onto the seafloor. Larger particles settle rapidly, whereas fine-grained particles may be advected from the drilling site depending on the currents (Neff, 2005; NRC, 1983). Drill cuttings, of coarser grain size than drilling fluids, will settle rapidly to the seafloor. Jones and Stokes Associates, Inc. (1989), as cited in EPA (1994), indicated that the majority of drill cuttings probably will be deposited within 100 m (328 ft) of the discharge point at all depths and current speeds. Drilling fluids and fine-grained cuttings could be dispersed over large areas, albeit in low concentrations, depending on the dynamics proximal to the discharge location (Neff, 2010). In areas without strong bottom currents, drilling fluids typically are concentrated within 500 m (820 ft) of the seafloor discharge location (Continental Shelf Associates, 2004). In high-energy environments such as Cook Inlet, relatively small amounts of the drilling fluids and cuttings accumulate near wellsites because deposits are quickly transported away by strong currents (Hannah and Drozdowski, 2005).

Given the strong tidal currents in Cook Inlet, drill cuttings are expected to be readily redistributed and well mixed with natural sediments within a few tidal cycles (EPA, 1994, 2013a). In contrast, fine-grained particles disperse into the water column and settle slowly over a larger area of the seafloor during redistribution by high tidal currents. These effects would be minor because discharged drilling fluids and cuttings would be rapidly diluted to very low concentrations, and suspended PM concentrations would drop below effluent limitation guidelines within several meters of the discharge (Neff, 2005).

In addition to turbidity, drilling discharges can introduce contaminants into the water column; in particular, the synthetics associated with SBF and elevated concentrations of some trace metals (NRC, 1983; Neff, 1987). Additionally, salts in WBF may alter local salinity. Drilling fluids typically are warmer than ambient seawater, and so temperatures locally increase when drilling fluids are introduced to the marine system. However, salinity and temperature changes are rapidly attenuated as drilling fluids are mixed with ambient seawater resulting in minor effects that would quickly become negligible.

With respect to trace metal inputs, the barite in WBF contains barium (Ba) and Cr in concentrations above what is normally found in marine sediments (Melton et al., 2000; Neff, 1988). Other heavy metal impurities are associated with barite, including Cu, Ni, Pb, and Zn, and hydrocarbons are introduced with drill cuttings (Breuer et al., 2004; Neff, 2008). However, results of almost four decades of field and modeling studies suggest that dilution of dissolved fractions and dispersion of particulate fractions of WBF discharges are extremely rapid (Neff, 2010). In North Sea cuttings piles, dissolved and particulate Ba, cobalt (Co), Cr, Cu, molybdenum (Mo), Pb, vanadium (V), and hydrocarbon concentrations were elevated compared to the surrounding environment with potential flux of metals from sediment pore to the water column (Breuer, Shimmield, and Peppe, 2008). It is expected there would be rapid dilution of trace metals in waters and sediments of Cook Inlet resulting in minor effects that would quickly become negligible.

4.3.2.3. Other Operational Discharges

Other operational discharges produced during the Proposed Action would include bilge, ballast, fire, and cooling water; sanitary and domestic wastes; and deck drainage (Section 4.2.3). Other discharges that could occur during exploration drilling include desalination unit discharges, BOP fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater (USDOI, BOEM, 2012b). Production activities can create well treatment and completion fluids. Water from hydrotesting may be discharged during construction and commissioning of oil and gas pipelines. Routine discharges would occur from platforms, drilling vessels, and supply and service/construction vessels as part of normal operations.

Bilge, ballast, and fire water as well as deck drainage would be treated on site before discharge, or disposed of at onshore facilities. On platforms and drilling vessels, sanitary and domestic wastes would be processed routinely using MSDs before being discharged overboard, or would be contained until they can be disposed of at proper onshore facilities. Waste recovered from the treatment processes would be containerized and shipped to shore for disposal. Cooling water discharge is regulated through NPDES permits as established by Section 316(b) of the CWA (see Section 4.2.4 for additional information). Compliance with applicable NPDES permits and USCG regulations therefore would prevent or minimize impacts on receiving waters.

Discharges from permitted oil and gas exploration facilities in Cook Inlet are expected to comply with all applicable marine water quality criteria developed pursuant to Section 304 of the CWA (EPA, 2013a). Discharges from exploration drilling operations are expected to meet the appropriate effluent limitation requirements listed in the proposed Cook Inlet Exploration General Permits as well as the appropriate Alaska Water Quality Standards in 18 AAC 70. In addition to authorizing the discharges of drilling fluids and drill cuttings from exploratory drill on the OCS, General Permit AKG-28-5100 also authorizes discharges of sanitary and domestic wastes, bilge and ballast water, and other non-drilling operational discharges for exploration facilities. Discharges associated with onshore activities (from wastewater facilities, processing facilities, or housing facilities, or during construction activities, pipeline installation, gravel extraction for pipeline and road) would operate under various discharge permits from the State of Alaska and other Federal agencies with authorities in those waters.

Vessels >24 m (79 ft) in length operating as a means of transportation during exploration would require NPDES permit coverage for incidental discharges under the Final 2013 Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (VGP) (EPA, 2013b). The VGP establishes effluent limitations to control materials that contain constituents of concern in the waste streams from vessels. 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 MARPOL 73/78, implemented by the USCG pursuant to 33 CFR 151. Vessels <24 m (79 ft) in length that are operating as a means of transportation may be covered under the VGP, or may instead opt for coverage under the VGP issued by the EPA. Discharges from seismic survey vessels and support vessels used during exploration activities would be covered by the VGP.

Bakke, Klungsøyr, and Sanni (2013) found that the effects of present operational discharges are local, and generally confined to within 1 to 2 km (0.6 to 1.2 mi) of a source in the water or on the seafloor, so that the risk of widespread impact from operational discharges is low; however, local water quality may be impacted by other operational discharges. For example, potential concerns include introduction of total suspended solids, waters with higher temperature and salinity than ambient waters, nutrients, organics, oil and grease, metals, compounds that affect pH, aquatic nuisance species, pathogens, and toxic and non-conventional pollutants. Biological oxygen demand (BOD) would increase through introduction of nutrients and organics, including petroleum products.

Cook Inlet is a high-energy environment with strong tidal currents and mixing that produces a rapid dispersion of soluble and particulate pollutants. Turbidity associated with introduction of suspended solids would achieve ambient levels rapidly, given sinking and sedimentation of larger particles, and dilution and dispersion of finer-grained particles during their advection. Discharges of drill cuttings, coarse-grained suspended solids, would be deposited within approximately a few hundred meters of their introduction site (Continental Shelf Associates, 2004; Neff, 2005, 2010), and could be transported during later resuspension events, further diluting their concentrations (Hannah and Drozdowski, 2005). Presumably, fine-grained particles introduced to the marine system would behave like drilling fluids, with the concentration of suspended particulates dropping below effluent limitation guidelines within several meters of a discharge point (Neff, 2005), allowing concomitant restoration of ambient turbidity levels.

Some types of operational discharges may influence local water temperatures and salinities. For example, once-through non-contact cooling water is discharged and may be 10°C to 15°C warmer than the surrounding seawater (EPA, 2009). This temperature difference can accumulate in the vicinity of the discharge if the vessel or structure is stationary (e.g., a vessel in port, a gas platform, a drillship) resulting in localized warming of the water. However, warmer water would rapidly dilute and mix to background temperature levels within the high energy environment of Cook Inlet. The temperature effect is estimated to dissipate within 50 m (164 ft) horizontally depending on several factors, including temperature differential, volume and rate of discharge, and degree of mixing in the discharge area (along current, with assumptions for along current direction and velocity) (EPA, 2012d). Similarly, any fluids with higher salinity than ambient waters would be diluted and the salinity signal reduced to background levels close to the input source by local mixing.

Domestic wastewater and treated sanitary waste would introduce organic materials that would not only increase suspended solids and turbidity, but could cause temporary localized BOD. However, all vessels with toilet facilities must have Type II or Type III MSDs that comply with 40 CFR 140 and 33 CFR 159 for sanitary wastes, and these regulate the release of waste so that the discharge contains <150 mg/L of suspended solids and a bacteria count <200 per 100 mL or no discharge occurs, and waste is transported to shore for disposal (Section 4.2.3).

Rainwater and other waters falling on contaminated areas of drilling rigs or platforms will pass through an oil-water separator prior to discharge so that deck drainage contains no free oil, as mandated by the NPDES permit. Well treatment, workover, or completion fluids; boiler blowdown discharges; excess cement slurry; and uncontaminated freshwater and saltwater would be subject to guidelines and stipulations in the relevant NPDES permit, including no discharge of free oil. However, within coastal waters, small volumes of discharges would occur during normal operations. If discharges occur within confined portions of some channels, the volume or flow of water may be insufficient to adequately dilute and mix the discharges, and result in localized degradation in water quality. Compliance with applicable state-issued or Federal NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters, but water quality could be affected in the coastal or confined portions of the embayment. These effects would be negligible to minor, as they would be localized and less than severe.

4.3.2.4. Trash and Debris, Including Non-Hazardous Domestic Waste

OCS oil and gas activities generate trash, called marine debris if accidently lost overboard, and these materials could impact water and sediment quality and benthic communities (NRC, 2008; USDOI, BOEM, 2012b). Lighter pieces of debris may float on the sea surface and adversely affect water quality and marine biota (NRC, 2008; NOAA, National Ocean Service, 2013). Potential impacts on water quality from marine debris are expected to be similar to those from the existing shipping and fishing industries. Heavy items such as welding rods, buckets, and pieces of pipe may accidentally fall overboard from a drilling rig or support vessel. These pieces of debris may have a minor localized impact on water quality due to physical or chemical decomposition.

4.3.2.5. Accidental Oil Spills and Gas Release

Section 4.2.14 describes accidental spills associated with the Proposed Action and the spill scenarios for impact analysis. Appendix A provides further details, modeling information, and findings.

Small Oil Spills (<1,000 bbl)

The estimated numbers of small spills for the Proposed Action are summarized and discussed in Section 4.2.14. Small spills under the Proposed Action include spills of diesel fuel and refined and crude oil. The magnitude and severity of impacts would depend on the spill location and size, type of product spilled, and environmental conditions at the time of the spill.

Small refined (e.g., diesel fuel) oil spills could occur throughout the Proposed Action from seismic survey vessels, drilling rigs, or support vessels. Refined oils such as gasoline, diesel, and aviation fuel are not persistent, do not form emulsions, and usually evaporate rapidly provided they are exposed to air. Refined oils contain only light fractions and primarily weather through evaporation. Evaporation increases with temperature and as wind speed increases.

Small refined spills on board a vessel or 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 by hydrocarbons causing potential short-term levels of toxicity in the immediate vicinity of the small spills.

A small diesel or other refined oil spill in offshore waters would produce a slick on the water surface affecting surface water quality by increasing the concentrations of petroleum hydrocarbons and their degradation products within the upper water column. Historically, the most likely type of small spill during offshore oil and gas exploration is a minor diesel fuel spill (USDOI, BOEM, 2012b), and most diesel spills have been ≤1 bbl. This spill size is estimated to be the most common in ongoing and future offshore activities (USDOI, BOEM, 2012b). Based on historical data from the Gulf of Mexico OCS, the average size for spills <1 bbl is 0.05 bbl, and the median size for spills of 1 to <10 bbl is 3 bbl (Anderson, Mayes and LaBelle, 2012).

The fate of a small diesel spill would depend on meteorological and oceanographic conditions at the time of the even. Given the location of the activity within the high-energy tidal Cook Inlet characterized by a large tidal excursion, and the short duration of a small spill, the opportunity for impacts to occur would be brief. The water-soluble fractions of diesel are dominated by two- and three-ringed PAHs, which are moderately volatile (NRC, 2003b). The constituents of refined oils are light to intermediate in molecular weight and can be readily degraded by aerobic microbial oxidation.

It is estimated that more than 90% of a small diesel spill would evaporate or disperse within 24 hours. Evaporation of diesel is temperature dependent and accelerated by strong winds. However, there is potential for a small portion of heavier fuel components to adhere to PM in the upper portion of the water column and sink. This generally occurs in coastal areas with high suspended solid loads (NRC, 2003b), as observed in upper Cook Inlet. The large tidal excursion in Cook Inlet transports suspended sediment to lower Cook Inlet. However, diesel oil also is readily and completely degraded by naturally occurring microbes (NOAA, 2006). BOEM (2012b) concluded that small diesel spills are not expected to persist as a slick on the surface of the water beyond a few days and are unlikely to make landfall prior to evaporating and degrading.

Small spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products because small spills of crude oil likely will be transported farther and affect larger areas of the water column and Cook Inlet. A small crude oil or condensate spill in 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, small crude oil and condensate spills could affect the localized surface quality of ice and surface water quality if the spill occurred in broken ice.

The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the activity/accident; however, small spills would be expected to result in short-term minor impacts to small areas.

Large Oil Spill (≥1,000 bbl)/Gas Release

A large crude oil spill, large condensate spill, large refined oil spill, or gas release have varying potential to occur under the Proposed Action. Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. The estimated number of large spills associated with the Proposed Action is discussed in Section 4.2.14. These spills could affect marine surface waters, coastal waters, and tidal riverine waters. A single large spill is described here, during the development phase, from an offshore pipeline, onshore pipeline, offshore platform/storage tank, or well. Hydrocarbons spilled into the ocean 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, emulsify and float, or sink to the subsurface, depending on the water uptake plus initial density of the spilled oil (NRC, 2003c). Water quality would be affected by hydrocarbons until the processes of dispersion, dilution, degradation, and weathering reduce oil concentrations.

Hydrocarbon concentrations in water have been measured during oil spills that indicate generally rapid removal of hydrocarbons from the water column. The concentration of dissolved and dispersed oil within the upper water column under the spreading oil slick of the Exxon Valdez Oil Spill was estimated to be 800 ppb in the top 10 m (33 ft) using the NOAA oil weathering model corresponding to less than 0.1% of the volume of water in the Prince William Sound (Wolfe et al., 1994). More than 90% of the water samples from the spill path analyzed for hydrocarbons contained <1 ppb total PAHs one month after the spill. A month after the spill, most water samples contained <0.1 ppb total PAHs (Wells, Butler, and Hughes, 1995). Total PAHs in 45 seawater samples collected between May and October 2010 during the *Deepwater Horizon* oil spill averaged 47 ppb (Sammarco et al., 2013). Boehm, Cook, and Murray (2011) reported a geometric mean of 0.007 ppb total PAHs in more than 6,000 whole unfractionated offshore water samples from the *Deepwater Horizon* oil spill between May and October 2010 (range: not detected to 146,000 µg/L (ppb)). Most samples (85%) were at or near background levels (i.e., total PAH concentrations of <0.1 ppb). Four months into the *Ixtoc* release (Gulf of Mexico, 1979 to 1980), hydrocarbon concentrations at 50 m (164 ft) depth measured >10 ppm at a distance of 8 km (5 mi) from the release, 0.02 ppm at 24 km (15 mi), and <0.005 ppm at 40 km (25 mi) (Boehm et al., 1982).

After the *Ekofisk Bravo* surface release in the North Sea in 1977, concentrations of volatile hydrocarbons (present mostly as an oil-in-water emulsion) were up to 0.35 ppm at a distance of 19 km (12 mi) from the incident site 1.5 days into the 7.5-day release (Grahl-Nielsen, 1978). Lesser amounts of oil (<0.02 ppm) were detectable in some samples collected 56 km (35 mi) from the site, and oil was undetectable in samples collected 89 km (55 mi) from the site. In more restricted waters during flat calm conditions, a test spill during the Baffin Island Oil Spill Project resulted in maximum hydrocarbon concentrations in the water column of 1 to 3 ppm (Green, Humphrey, and Fowler, 1982). These concentrations were reached within 2 hours of the spill and persisted for 24 hours. No oil was detected deeper than 3 m (9.8 ft), and the highest concentrations were found in the upper meter of the water column (Mackay and Wells, 1983).

In situ cold-water measurements (Payne et al., 1987) indicated that concentrations of individual components in an oil slick decrease significantly 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 they accumulate in the underlying water. Surface oil slicks become patchy, and the total area of widely separated patches is greater than the actual amount of surface area covered by oil. PAH from any discharge quickly become adsorbed on particulate matter and large amounts from the water are then deposited in bottom sediments where they are readily accumulated by aquatic biota (Neff, 1986).

Oil deposited as sediments or tarballs could persist in the environment and affect near-bottom water quality. The observed range in deposition of oil in bottom sediments following offshore spills is 0.1% to 8% of the slick mass (Jarvela, Thorsteinson, and Pelto, 1984). In nearshore areas, surf, tidal cycles, and inshore processes can mix oil into seafloor sediments. Farther offshore where suspended sediment loads are generally lower, only approximately 0.1% of the crude would be incorporated into sediments within the first 10 days of a spill (Manen and Pelto, 1984). Oil with a heavier composition could persist as individual tarballs in the water column and on the seafloor. It is estimated that over 1,000 days, 15% of tarballs could 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, tarballs could be widely dispersed.

Decomposition and weathering processes for oil are much slower in cold waters than in temperate regions. Oil weathering rates are slower because there is less evaporation loss. If oil is spilled under sea ice, a decrease in the rate of emulsification stemming from reduced wave-action occurs, compared to open-water conditions (Barber et al., 2014). 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 effects 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 subject to advection and dispersion. An oil spill that occurs in broken ice or under pack ice during the deep winter would freeze into the ice, move with the ice and melt out of the ice the following summer. In early to mid-March, the percent chance of occurrence for ice of at least 5/10th concentration (i.e., 50% of the water surface covered by ice) ranges from >25% at the southern end of the proposed Lease Sale Area to 50% to 75% at the northern end (Mulherin et al., 2001). Spills in first-year ice would melt out in late spring. Spills released from the ice would be unweathered and have the characteristics of fresh oil.

Although unlikely, BOEM estimates that a well control incident of a single well could release 8 MMcf of natural gas in one day. In the event of a natural gas release, CH_4 would be released into the water and rise through the water column. Subsurface water quality would be altered temporarily in deeper, colder waters in which gases may be water soluble. Upon reaching the surface, the gaseous methane would react with air, forming water and CO_2, 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. The near-surface water quality would have higher concentrations of CO_2 than is natural, which could affect processes and reactions in the microlayer at the water-air interface such as egg and larvae respiration (GESAMP, 1995).

Impacts of the Proposed Action on water quality though localized would remain for a longer term over larger area than a small spill; the resulting larger impact is moderate for a large spill.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread. Spill impacts and cleanup operations would be influenced by time of year in Cook Inlet; in particular spill response can be both hindered and aided by the presence of ice (see discussion in Section 4.2.14.3).

Mechanical recovery of spilled material would generally improve water quality; during an offshore oil spill response it would add little or no negative impacts. The net effect of mechanical recovery would result in less PAH remaining on the surface, subsequently migrating into the water column and ultimately accumulating in bottom sediments. In open water the deployment and recovery of containment booms and use of skimmers to recover the spill and would not add pollutants to the water. If the length of a containment boom's skirt is too long drags on the bottom, disturbed sediments could more readily mix with oil. For oil spill recover to preclude onshore impacts with sediments, NOAA (2010c) expressed caution for the use of correctly sized containment booms during nearshore deployment and/or recovery of containment booms in shallow habitats, while deflecting oil away from shore, or to trap and collect oil at the shoreline and prevent stranded oil from refloating and affecting adjacent areas, and when preventing oil being washed over a beach into a lagoon or backshore area. Physical damage from containment and collection procedures could occur if the effective current (tidal or stream flow) or towing speed exceeds 0.7 knots perpendicular to the boom; environmental effects would be minimal, if disturbance during deployment and maintenance is controlled (NOAA, 2010). Negligible to minor water quality impacts would be increased in the event either booms or skimmers cause bottom sediments to be disturbed and mixed with the oil spill during mechanical recovery; these impacts would be localized and expected to be short-term in shallow coastal areas. Minor environmental effects from other mechanical recovery methods may also enhance oil penetration and quantity of contaminated sediments, including the placement of a physical barriers consisting of earthen berms, trenching, or filter fences. NOAA (2010) indicated such recovery methods may disrupt or contaminate adjacent vegetation as well as sediments. Coastal beaches or the shoreline profile should be restored depending upon the local conditions; recovery may take weeks to months on gravel beaches (NOAA, 2010) and years to decades in isolated locations along the coast in Prince William Sound (Gilfillan et al., 1995; Page et al., 1995; Short et al., 2004; Ballachey et al., 2015). However, the toxicity from oil subsided following the 1989 Exxon Valdez Oil Spill as residues of weathered were highly asphaltic, not readily bioavailable, and not toxic to marine life by 1991, the environmental effects became negligible (Boehm et al., 1995; Page et al., 1995; Short et al., 2004). High pressure washing in intertidal habitats was a destructive mechanical method used during the Exxon Valdez Oil Spill (Lees, Houghton and Driskell, 1996; Hoff and Shigenaka, 1999); while this form of washing would improve water quality, the loss of intertidal fauna and flora was substantial and not expected to be used in the future.

Use of dispersants generally improve the water quality during an oil spill response by reducing the oil/water interfacial tension making it easier for waves to break up oil into larger number of smaller particles (NOAA, 2010). Relative to the spill, the dispersed oil including the dispersants would add little to no negative impacts on measured water quality parameters. However, the dispersed oil could adversely organisms in the upper water column until the dispersed oil and dispersant is sufficiently diluted; and the use of dispersants in shallow water could affect benthic resources (NOAA, 2010); see the Spill Response Activities discussion on lower trophics in Section 4.3.4.6. The net effect of dispersants would reduce impacts to sensitive shoreline habitats and animals that use the water surface, and result in less PAH remaining on the surface, subsequently migrating into the water column. When dispersed within the water column natural biodegradation can occur with the oil diluted potential ACUTE (immediate) and CHRONIC (long-term) toxicity to organisms would be rapidly reduced, and do not sink to the bottom. (Scholz et al. 1999). The dispersant is unlikely to contribute significantly to adverse effects, even in multiple applications (Boyd et al., 2001).

In-situ burning of spilled oil floating slicks, early in the spill event, is effective in removing oil from the surface of the waterbody when contained in fire-resistant booms or any natural barriers such as ice or the shore (NOAA 2010). In-situ burning is upwards of 90% effective in removing the spilled oil according to the Scholz et al. (2004). Oil can also be burned on land when it is on a combustible substrate such as vegetation, logs, and other debris (NOAA 2010). Under the ideal conditions in-situ burning would be the most effective for water quality recovery. After the in-situ burn the remaining residue is non-toxic, but could act as a physical barrio. Removal of the residue would be desired in most cases to benefit the reestablishment of aquatic and/or terrestrial life (Scholz et al., 2004). There would be little to negligible impacts on measured water quality parameters.

4.3.2.6. Impact Conclusions

For routine operations, the expected impacts to water quality would be from seafloor disturbance and habitat alteration, drilling and other operational discharges, water withdrawals, trash and debris, and vessel traffic. Most impacts from routine operations would be short-term or transient, localized to the project infrastructure or along support vehicle/aircraft routes, and affect relatively small offshore areas since all infrastructure and activities associated with the Proposed Action will occur >4.8 km (3 mi) from the coastline. Overall, the effects from routine activities would be short-term, localized, and **minor**.

Small (<1,000 bbl) and large (≥1,000 bbl) accidental oil spills stemming from fuel transfer accidents, platform fuel tank ruptures, well blowouts of gas, and from platforms, MODUs, and pipelines could occur under the Proposed Action. While most accidental spills would be small and would have relatively minor impacts on water quality, large spills that reach coastal areas could have more persistent impacts, impact a larger area, and require remediation. A large spill assumed during the development and production phase of the Proposed Action might affect water quality along widespread areas of the coastline and near important habitats, although the combined probability of oil spreading as far south as Shelikof Strait and east of Kodiak Island within 30 days is <2%. Although unlikely, impacts from large spills could result from shoreline oiling and mechanical damage to the shoreline during the cleanup process. Heavy oiling through direct contact with a spill would result in degraded water quality, and natural bioremediation processes would be relatively slow in the cold environments of Cook Inlet. If a large spill occurred under ice, it might have long-lasting albeit localized effects. Overall, impacts to water quality from accidental small spills are deemed **minor** due to the localized and short-term nature of the impacts. A large spill may result in **moderate** impacts, based on the potential for widespread and long-lasting impacts. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for water quality for either routine activities or accidental spills. Also, GIUE (oil spill drills), that are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for water quality with regard to routine activities.

4.3.3. Acoustic Environments

IPFs associated with routine operations and non-routine events for the acoustic environment are (1) noise, which includes active acoustic sources, drilling and equipment noise, and vessel noise (2) aircraft traffic and noise, and (3) accidental oil spills and gas releases. The impact discussion provided includes the acoustic habitat encompassing the proposed Lease Sale Area and adjacent waters. Introduction of noise into the underwater habitat could cause direct impacts to species occupying that environment. More typically, however, the introduced noise masks specific frequency bands within the overall habitat. Species that rely on these frequency bands for ecological functions thereby are presented with a loss or degradation of available habitat. Potential impacts to the acoustic environment from routine operations include the following:

- Overall increase in sound levels throughout the proposed Lease Sale Area
- Prolonged loss of low-frequency habitat from continuous sources

- Temporary loss of low-frequency habitat and broadband habitat from high-power impulsive and continuous sources
- Alteration of soundscape characteristics
- Potential increase in sound levels in areas outside the proposed Lease Sale Area and potentially in habitat that is “closed” to routine operations

4.3.3.1. Noise

Active Acoustic Sound Sources

Active acoustic sources include seismic airguns, acoustical positioning systems, subbottom profilers, and multibeam echosounders. These sources typically are identified as impulsive sources with multipath reflection and refraction. Sound propagation and reverberation from high-energy sources becomes highly complex in shallow water and within bordered ocean basins such as Cook Inlet. Unlike open ocean environments, the propagation signatures can increase the acoustic levels within a habitat over time similar to that of a continuous source (Guerra et al., 2011). Measurements by Guerra et al. (2011) showed that seismic surveys increased the background noise over ambient by 30 to 45 dB within 1 km (0.6 mi) of the activity, 10 to 25 dB within 15 km (9 mi), and with detectable increases at distances up to 128 km (80 mi) during the activity. Aerts and Streever (2016) demonstrated that standard propagation modeling provided a poor fit to *in situ* measurements with differences up to 130 km (81 mi) for the 120-dB isopleths. Although there may be some incongruity between models and detailed field measurements, numerical modeling is a powerful tool used in predictive assessment of acoustic impacts. Current models use the best available science to be applied at appropriate levels and without unnecessary costs and delays required for more detailed analysis.

As discussed in Section 3.1.6, Cook Inlet is already a relatively noisy environment due to natural activity and anthropogenic sources. The Proposed Action estimates that development would occur near the existing commercial oil and gas fields in state waters in Cook Inlet (see Section 2.4). Generally, the proposed alternative would result in one to two deep-penetrating marine seismic surveys (likely to be 3D seismic surveys using towed streamers or OBN receivers) and four to five geohazard surveys. Airgun sources will produce the highest energy noise; however, the propagation and impact on the habitat will depend highly on the source configuration (Table 4.3.2-5) (Genesis Oil and Gas Consultants Ltd., 2011).

Table 4.3.2-5. Single Airgun and Airgun Array SPL and Sound Exposure Level (SEL) Measurements

Source Type	Volume (in^3)	Pressure (psi)	Water Depth (m)	Measurements Provided: Rms dB re 1 µPa @ 1 m (unless stated)	Peak-Peak level dB re 1 µPa @ 1 m (unless stated)	0 Peak dB re 1 µPa @ 1 m (unless stated)	SEL dB re 1 $µPa^2$ @ 1 m	Measurement Bandwidth (kHz)	Reference
Airgun Single	40	Not reported	15	129 dB re 1 µPa @ 5 km	186*	Not reported	Not reported	0.020- 20	Greene and Richardson, 1988
Airgun Bolt Gun	40	1,500	‘Shallow’	191	200*	Not reported	Not reported	Not reported	Nedwell and Edwards, 2004
		2,000		193	202*	Not reported	Not reported	Not reported	
Gas Injector Airgun Non–GI Mode	103	2,755	263	216	229	224	202	0.005-80	Breitzke et al., 2008
Array 4 Guns	280 (4×70-in. guns)	Not reported	48	Not reported	249	242.7	Not reported	0.005-20	Patterson et al., 2007
Array	330	Not reported	34	167 dB re 1 µPa @ 3 km	226*	Not reported	Not reported	0.005-20	Greene and Richardson, 1988
Array GI Guns Non-GI Mode	452	2,755	263	224	236	231	210	0.005-80	Breitzke et al., 2008

Source Type	Volume (in^3)	Pressure (psi)	Water Depth (m)	Measurements Provided				Measurement Bandwidth (kHz)	Reference
				Rms dB re 1 µPa @ 1 m (unless stated)	Peak-Peak level dB re 1 µPa @ 1 m (unless stated)	0 Peak dB re 1 µPa @ 1 m (unless stated)	SEL dB re 1 μPa^2 @ 1 m		
Array GI Guns True GI Mode	452	2,755	263	225	241	238	211	0.005-80	Breitzke et al., 2008
Airgun Single	518	2,030	263	221	237	234	207	0.005-80	Breitzke et al., 2008
Array 8 Guns	1,049	2,000	42	260.4	266*	Not reported	Not reported	0.005-20	Patterson et al., 2007
Array 8 VLF Prakla Seismos Guns	1,464.5	1,740	263	228	243	240	214	0.005-80	Breitzke et al., 2008
Array 3 G-Guns	1,562	2,030	263	227	241	237	213	0.005-80	Breitzke et al., 2008
Array 12 Guns	1,709	Not reported	20	179	233*	Not reported	Not reported	0.020- 20	Greene and Richardson, 1988
Airgun Single	2,000.5	1,885	263	230	242	239	216	0.005-80	Breitzke et al., 2008
Array 24 Guns	3,147	2,000	42	266.4	272*	Not reported	Not reported	0.005-20	Patterson et al., 2007
Array 18 Guns	3,955	Not reported	100	262.9	271*	Not reported	Not reported	Not reported	Nedwell and Edwards, 2004

Note: *Conversion from measurement value to peak-peak performed by Wyatt (2008). From: Genesis Oil and Gas Consultants Ltd. (2011).

Marine seismic surveys conducted on leases generally will last two months or less (depending on the number of leases) and occur early in the exploratory phase. Given the size of the proposed Lease Sale Area and the geographic boundaries of Cook Inlet, it is expected that any marine seismic surveys will produce an increase in noise in the area of the surveys. Acoustical positioning (or pinger) systems may be used to position and interpolate the location of OBNs. A vessel-mounted transceiver calculates the position of the nodes by measuring the range and bearing from the transceiver to a small acoustic transponder fitted to every third node. The transceiver uses sonar to interrogate the transponders, which respond with short pulses that are used in measuring the range and bearing. The system provides a precise location of every node as needed for accurate interpretation of the seismic data. Because the transceiver and transponder communicate via sonar, they produce underwater sound levels. A typical transceiver has a transmission source level of 197 dB re 1 µPa rms and operates at frequencies between 35-55 kHz. The transponder produces short pulses of 184-187 dB re 1 µPa rms at frequencies also between 35-55 kHz (NMFS, 2015g).

Geohazard surveys are expected to occur more frequently but have shorter duration, lower source levels, and, in some cases, much higher frequencies that do not propagate far beyond the source. The seismic and associated support vessels also will contribute to low-frequency noise within the environment during surveys. For all surveys, localized areas of the acoustic environment near the seismic sources or within sound transmitting channels will be impacted the most; however, detectable changes in the entire acoustic environment within the proposed Lease Sale Area can be expected during any single survey. The greatest impact will occur from the marine seismic surveys through the loss of acoustic habitat availability due to noise as described in Section 3.1.6. Impacts from the active sound source will cease as soon as the survey is complete and full recovery of the acoustic environment to pre-survey conditions is expected. Impacts from active acoustic sources to species may be different than the impacts to the acoustic environment and are discussed in applicable portions of Section 4.3.

Drilling and Equipment Noise

Drilling noise comes from the drilling platform equipment and the drilling activity itself. Equipment noise takes into account only the noise produced by the drilling platforms when not actively drilling. Support vessels and aircraft will also contribute to the sound levels produced around a drilling operation. Vessel and aircraft contributions outside of the drilling platforms are described separately in the following section and Section 4.3.3.1. It is important to note, however, that the combination and interaction of all noise sources during any single activity has a greater effect on acoustic habitat than any single noise source.

Drilling noise can be expected to occur in the exploratory and development phases of the E&D Scenario. There are four potential types of platforms that could be used for drilling: (1) jack-up rigs, (2) semisubmersibles, and (3) drillships, all of which are mobile platforms used for exploration and delineation wells; and (4) production platforms, used for drilling service and production wells. The mobile platforms often utilize use DP for station-keeping, which can increase the sound levels produced by the drilling platform during drilling and non-drilling activities; however, measurements taken from the same platforms during drilling and non-drilling activities showed a marked increase in SPLs during active drilling (Greene, 1986; McCauley et al., 1998; Nedwell and Edwards, 2004; Richardson et al., 1995).

Measurements taken during drilling operations reported for the drillship *Discoverer* in the Chukchi Sea showed broadband (10 Hz to 32 kHz) source levels up to 182 dB (unspecified units) (BOEM EA March 2015). Other measured studies have shown source levels up to 195 dB re 1 μPa @ 1 m during drilling from drillships.

Semisubmersibles are expected to produce slightly lower overall source levels than drillships with Richardson et al. (1995) reporting broadband source levels at approximately 154 dB re 1 μPa @ 1 m. McCauley et al. (1998) showed a 4-dB increase in noise levels between a drilling and non-drilling semisubmersible.

Results from measurements taken during drilling from a jack-up barge source levels lower than drillships and semisubmersibles. Todd and White (2013) recorded sound levels from a bottom-founded jack-up drill rig in the North Sea and showed measurements up to 120 dB re 1 μPa with dominant frequency ranges between 2 and 1,400 Hz.

Production platforms will drill the production and service wells during the development phase. Detailed measurements taken by Green and Blackwell (2003) of a production platform in Cook Inlet showed broadband (10 Hz to 20 kHz) sound levels up to 119 dB re 1 μPa without drilling operations. Given the 4-dB increase showed by McCauley (1998), sound levels for a production platform while drilling is expected to be 123 dB re 1 μPa.

The E&D Scenario estimates that 7 to 10 exploration and delineation wells will be drilled over a 4-year period, followed by 55 to 66 production and service wells drilled from the production platforms over a 7-year period. Individual drilling operations are expected to last 30 to 60 days per well with operational activities to support operations up to 30 days prior to and after drilling. These scenarios therefore represent approximately 1,900 to 4,000 drilling days (or 13% to 28% of the 40-year E&D Scenario. The habitat is expected to return to pre-activity conditions after the drilling has been completed and equipment leaves the site. Impacts to species from drilling and equipment noise may be different than the impacts to the acoustic environment and are discussed in applicable portions of Section 4.3.

Equipment noise from mobile platforms will be dominated by the DP thrusters whereas production platforms are likely to produce elevated noise levels during production, water injection, and decommissioning operations. Measurements by Hannay et al. (2004) of an operating drilling platform during production and water injection showed broadband signatures of 162 dB re 1 μPa @ 1 m. Recordings of a non-drilling production platform in Cook Inlet were collected by Blackwell and Greene (2003) at six stations ranging from 0.3 to 19 km (0.2 to 12 mi) from the platform. The highest broadband levels occurred 1.2 km (0.75 mi) from the platform (119 dB re 1 µPa) and decreased to background levels at 19 km (11.8 mi) with 84% of the strongest tones <500 Hz. There were "spikes" in sound levels at frequency bands between 30 and 40 Hz; they concluded that vibration of machinery above the water is likely transferred into the seafloor causing propagation of the 30 to 40 Hz band farther from the platform. The fact that higher noise levels occurred farther from the source is a good indication of the complexity of the propagation characteristics in Cook Inlet and the difficulty in assessing the contribution of single noise sources. Platform equipment noise will be the predominant noise contributor during the production phase. Sound levels are expected to be continuous for the life of the platform. Under the Proposed Action, two to three platforms are expected to be installed in the proposed Lease Sale Area, and changes to the acoustic environment within frequency bands <200 Hz can be expected up to 10 to 20 km from each platform. During decommissioning, there will be severance equipment noise as well as platform noise. In Cook Inlet, it is unlikely that explosive severance would be used due to the shallow water depths; instead, abrasive and mechanical severance likely will be used. The process of decommissioning involves having additional equipment and vessels on site; preparing the piles, jackets, conductors, and wells; and severing the individual structures from the seafloor into manageable components that can be placed on a barge. Final steps involve site clearance and seafloor surveys. The short-term (1 to 2 weeks) nature of decommissioning will have an equally short-term impact on the acoustic habitat.

Vessel Noise

Vessel noise is one of the main contributors to overall noise in the sea (Jasny et al., 2005; NRC, 2003a). All vessels associated with the E&D Scenario under the Proposed Action will contribute to an increase in the ambient noise levels of the existing acoustic environment. Vessel noise impacts will be within the low-frequency range (<100 Hz). In measurements of noise from container ships in open water, McKenna (2012) showed received levels at 40 Hz rose above background levels at 16 km (10 mi) from the receiver, and that these noise levels remained above ambient for more than 30 minutes. At 95 Hz and 800 Hz, received levels rose above background to a distance of 8.5 km (5.3 mi), again, for over 30 minutes (McKenna, 2012). While all vessels will contribute to the overall noise in the environment, propagation of the noise is likely to be complex given the confinement and shallow water depths in the proposed Lease Sale Area. In similar regions, Heaney (2014) showed that localized ambient noise is likely to be driven entirely by the nearest ship; this differs from deep open water where many ships collectively add to the total received noise levels. This is supported by data from measured sound exposure levels (SELs) produced by support vessels working in the Chukchi Sea that showed vessel noise decreased to 160 dB within 0.48 km (0.3 mi) of the source and to 120 dB within <9.7 km (6 mi) of the source (Bisson et al., 2013).

There are existing pockets of high commercial vessel activity in Cook Inlet (see Section 3.1.6). These likely will not see significant changes in the acoustic habitat. However, in areas of the proposed Lease Sale Area without high levels of existing vessel traffic, even a small increase in large vessel activity will result in a change within the low-frequency habitat. Under E&D Scenario, there is likely to be an increase in commercial vessels throughout the entire 40-year period. Change will occur over the 40-year period as there will be continued vessel support for all activities within the proposed Lease Sale Area.

Aircraft Traffic and Noise

Aircraft noise is a minor but long-term contributor to the acoustic environment. Aircraft noise will continue to be received from existing sources not associated with oil and gas development, namely Ted Stevens International Airport (ANC) and Joint Base Elmendorf-Richardson (JBER) in Anchorage. Aircraft operating to and from platforms and vessels will increase the localized noise levels within Cook Inlet. Offshore oil and gas operations are serviced by helicopters from a shore base. The typical helicopter used would be the Sikorsky S-92, or a similar craft, flying between the shore base and the platforms or vessels. The dominant sound energy for aircraft is generally <500 Hz (Greene and Moore, 1995). Rotor and engine sounds transfer into the water within a 26° cone beneath the aircraft (Urick, 1972, as cited in

Richardson et al., 1995). Due to Doppler shifts, the received sound levels within any stationary point will diminish when an aircraft passes overhead. Therefore, aircraft flyovers are heard underwater for a very short duration and are most pronounced as the aircraft approaches or leaves a location. During routine operations, the aircraft must be able to land on a relatively stationary platform and thus position-keeping is often maximized at this time. Therefore, increases in indirect noise will be realized from the platform or vessel operations with a small noise contribution from the aircraft itself.

4.3.3.2. Accidental Oil Spills and Gas Releases

The impact discussion provided includes the acoustic habitat encompassing the proposed Lease Sale Area and adjacent waters. Introduction of noise into the underwater habitat could cause direct impacts to species occupying that environment. More typically, however, the introduced noise masks specific frequency bands within the overall habitat. Species that rely on the frequency bands for ecological functions thereby are presented with a loss or degradation of available habitat. Impacts of any accidental spills to the acoustic environment will be directly related to the size and number of response vessels and the size of the work area. Duration and extent of habitat disturbance will be based on the required response levels. Potential impacts to the acoustic environment from response to accidental spills include the following:

- Temporary increase in sound levels throughout the proposed Lease Sale Area
- Temporary increase in sound levels in areas outside the proposed Lease Sale Area and potentially in habitat that is “closed” to routine operations
- Temporary fragmentation of acoustic habitat

Small Oil Spills (<1,000 bbl)

The estimated numbers of small spills estimated in the Proposed Action are summarized and are discussed in Section 4.2.14. Under the Proposed Action, response to small spills occurs entirely within existing operations. No added vessels would be required for cleanup or response; therefore, small spills will have no impact on the acoustic habitat.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. The estimated number of large spills for the Proposed Action is discussed in Section 4.2.14. Large oil spills will require response, recovery, and sampling vessels and therefore will increase the sound levels in the area of the spill and its trajectories. These increased noise levels are expected to be concentrated in the low-frequency range (<100 Hz) and be widespread in the proposed Lease Sale Area for the duration of response activity. Operational vessels may include oil spill response tugs and barges, oil spill response vessels (OSRVs), oil storage tankers (OSTs), boom and skimmer units, ROV vessels, and sampling vessels. Additional vessels will support personnel, operations, and safety/security. Depending on the extent of the spill and the response plan, the extent of noise contributions from these vessels could affect the entire proposed Lease Sale Area and beyond. The source levels and frequencies from response equipment and vessels could produce high sound source levels that will propagate over long distances.

Although unlikely, BOEM estimates that one well control incident involving a single well could release 8 MMcf of natural gas in one day. A large gas release and ensuing explosion and fire would result in increased sound levels in the proposed Lease Sale Area due to the blowout itself and from response, recovery, and sampling vessels. Increased noise levels are expected to be concentrated in the low-frequency range (<100 Hz). Due to the limited estimated time frame of a gas release (<1 day), increased ambient sound levels due to a gas release are not expected.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Spill Response Activities

The impacts from any oil spill response will be driven mainly by the number and type of vessels operating and this effect on the acoustic resource will not change between conditional and combined probabilities.

4.3.3.3. Impact Conclusions

Potential impacts to the acoustic environment will occur from IPFs associated with routine operations and non-routine events. The noise IPF comprises active acoustic sound sources, drilling and equipment noise, and vessel noise. During active acoustic sound source surveys there will be measureable and widespread increases in noise levels, particularly in the frequency bands below 500 Hz; the number of these surveys will be small and of temporary nature. Drilling and equipment activities are temporary in nature, with a relatively localized acoustic footprint, but will commonly occur during the Proposed Action. Vessel activity is already present in the acoustic habitat. The E&D Scenario activities will increase the chronic vessel noise throughout the proposed Lease Sale Area. Aircraft traffic has a relatively small noise footprint during takeoff and landing with limited noise contribution within an already high-noise operation. The acoustic habitat will return to pre-event conditions when all phases are completed. Due to the temporary nature of the additional acoustic sources and the generally short duration of peak response efforts for large spills, impacts to the acoustic environments are expected to be **minor** for routine activities. Impacts to the acoustic environment from a spill will occur from response activities from vessels and equipment. Impacts from small spills are expected to be **negligible** due to most spills evaporating and dissipating within 24 hours without any required response. Impacts from a large spill would be **minor** due to the generally short duration of peak response effort. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for acoustic environments for routine activities or accidental spills.

4.3.4. Lower Trophic Level Organisms

IPFs associated with routine operations and non-routine events for lower trophic level organisms are (1) seafloor disturbance and habitat alteration; (2) drilling discharges; (3) other operational discharges; (4) water intake; (5) physical presence (including lights); and (6) accidental spills (Table 4.2-1). Potential impacts to lower tropic level organisms in the offshore environment from routine operations include the following:

- Disturbing and altering habitat from structure emplacement (Daigle, 2011; Manoukian et al., 2010; Montagna, Jarvis, and Kennicutt, 2002)
- Providing new substrate for colonization (Gallaway and Lewbel, 1982)
- Smothering, anoxia, and contamination from drilling discharges (Neff, 2010)
- Contamination from other discharges; impingement or entrainment from water intake (Choi et al., 2012)
- Attraction due to lighting leading to increased predation (Keenan, Benfield, and Blackburn, 2007)

4.3.4.1. Seafloor Disturbance and Habitat Alteration

Seafloor disturbance and habitat alteration in the Proposed Action will result from drilling wells and placing anchors, nodes, cables, sensors, pipelines, and other equipment on the seafloor for the completion of various activities described in the E&D Scenario. Table 4.2-2 shows which development phases involve seafloor disturbance and habitat alteration.

The installation of fixed platforms would disturb soft sediment habitat where the legs encounter the seafloor and where subsea equipment (such as reentry collars and BOPs) are installed. Assuming 10 exploration and delineation wells will be drilled with a jack-up rig, a total of approximately 10 ha (25 ac) of seafloor could be disturbed as a result of potential jack-up rig placement activities resulting from Lease Sale 244.

Additionally, two to three steel-caisson production platforms will be installed in Cook Inlet, resulting in a seafloor area of up to approximately 1.5 ha (3.75 ac) being disturbed by each platform depending on the platform design. Trenching two new offshore oil pipelines and three new offshore gas pipelines will disturb an estimated 161 to 322 ha (398 to 766 ac) of seafloor. The benthic organisms in these areas would be crushed or buried.

Chronic local seafloor disturbance (physical compaction and sediment resuspension) would result from movements of anchors and chains or lines. A disturbed area on the seafloor called the “anchor sweep” forms by the swing arc of anchor lines scraping across the bottom within the range allowed by the anchoring system configuration. The actual area of seafloor affected by anchoring operations would depend on water depth, currents, size of the vessels and anchors, and length and number of anchor chains. The areal extent of seafloor affected by anchored structures would increase with water depth because of the use of larger anchors and longer anchor chains.

Furthermore, the Proposed Action will require installation of two new oil pipelines and three new gas pipelines to be trenched into the seafloor. Pursuant to NTL 2005-A03, BOEM will require site-specific information regarding potential archaeological resources and sensitive benthic communities prior to approving any activities involving seafloor-disturbing activities or placement of bottom-founded equipment or structures in the proposed Lease Sale Area. BOEM will use this information to ensure that physical impacts to archaeological resources or sensitive benthic communities are avoided. If trenching is not possible due to unsuitable sediments, anchors may be used to provide stability to the pipeline to resist strong tidal movements. The pipelines will be constructed along the corridor between Homer and Nikiski.

The platforms and surface-laid pipelines would create hard substrate, and the area on and immediately around the platform would have habitat functions and biological communities very different from these in the pre-construction period (Gallaway and Lewbel, 1982). Algae and sessile invertebrates (e.g., mussels, barnacles, bryozoans) would attach to the platform and would in turn attract hard bottom organisms (Stachowitsch et al., 2002). The ecological function and value of artificial reef habitat is relative as some species may benefit while others do not (Daigle, 2011). In addition, sediment grain size and the biogeochemical processes around the platform could be altered by the flux of biogenic material from the platform to the seafloor. For example, an increase in shell material and organic matter likely would result along with a transition to benthic species adapted to these conditions (Montagna, Jarvis, and Kennicutt, 2002). The replacement of soft sediment with artificial reef (e.g., platform legs, pipelines) would exist during the production phase, as all infrastructure would be removed or buried during decommissioning. In soft sediments of the deep sea, communities may form on mooring structures, but colonization likely would be slow, and mooring structures would be completely removed during decommissioning, so any impacts would be temporary.

Where pipelines are buried, benthic organisms within the trenched corridor could be killed or injured, and organisms on either side of the pipeline could be buried by sediments. Pipelines placed on the sediment surface would replace the existing soft sediments with man-made substrate that sessile invertebrates may colonize over time. Vessel anchoring during pipeline placement also would disturb soft sediment. Anchor and mooring impacts from pipeline placement vessels would be eliminated if DP systems rather than anchors were used during pipeline placement. The recovery period for soft sediment benthic habitat disturbed by pipeline placement would depend on factors such as water depth, sediment type, and community composition. A literature review of studies of benthic community change around platforms suggests that benthic communities may return to baseline conditions 1 year after the cessation of drilling (Ellis, Fraser, and Russell, 2012). Disturbed sediments with a greater proportion of sand to mud may fill in with fine silty material, altering grain size and potentially inhibiting the colonization of species that existed in the area prior to the disturbance. Impacts to the benthic community would be minor due to the localized nature of the disturbance and the expected recovery of benthic communities after activity ceases.

4.3.4.2. Drilling Discharges

Routine operations potentially affecting lower trophic level organisms include operational discharges from exploration, development, production wells, and production platforms. These operational discharges include SBF and WBF drilling fluids and cuttings. Well-related discharges will occur in the exploration and development phases of the E&D Scenario. Drilling fluids and cuttings are described in Sections 4.2.2 and 4.2.11, and Table 4.2-2 shows which development phases involve their discharge.

As discussed in Section 4.3.2.2, in high-energy environments such as Cook Inlet, little of the drilling fluids or cuttings are likely to accumulate near wellsites because deposits are quickly diluted and transported away by strong currents and adverse effects of the discharges cannot be detected (Hannah and Drozdowski, 2005; Neff, 2005). Consequently, drilling fluids and cutting solids could be dispersed over large areas, albeit in low concentrations, depending on oceanographic and current schemes in the location of the discharge (Neff, 2010).

While the total volumes of drilling fluids and cuttings discharged to the ocean during drilling operations are large, impacts to planktonic communities are minimal (Neff, 2005; NRC, 1983). Discharges of small amounts of materials are intermittent and take place during drilling operations spaced over a few to several months. As such, discharged drilling fluids do not increase to high concentrations in the water column, and affects a small parcel of water (Neff, 2005). According to the NRC (1983) and Neff (2005, 2010), periodic minor increases in turbidity and suspended particulate material concentrations in the upper water column during discharges of drilling fluid and cuttings are unlikely to have an effect on phytoplankton, zooplankton, and pelagic animal communities in the vicinity of the drill rig.

Neff (2010) conducted a review of the fate and effects of drilling fluids and cuttings in cold water environments and concluded that metals and hydrocarbons in WBF drilling fluids and cuttings are not bioavailable and do not enter marine food webs or bioaccumulate in aquatic organisms. Discharge of drilling fluids and cuttings in strict compliance with local environmental regulations is not likely to cause toxic effects in water column and sediment-dwelling plants and animals near the discharge. Minimal effects on benthic macrofaunal and megafaunal communities are nearly always restricted to sediments within approximately 91 m (300 ft) of the discharge. The high-energy environment of Cook Inlet will result in the rapid dilution and dispersion of drilling fluids and cuttings, decreasing the effects on benthic communities within close proximity of the discharge (Neff, 2005).

Overall, the ecological effects of drilling fluids and cuttings are caused by the physical disturbance of the water column and benthic environment. An increase in suspended particle concentrations from the discharge of drilling fluids and cuttings may clog the gills or digestive tracts of zooplankton or benthic filter-feeding invertebrates, and accumulation of drilling wastes on the seafloor buries some of the immobile benthic infauna (Neff, 2010). Additionally, changes in sediment grain size and sediment texture may render sediments unsuitable for settling and growth of some species, while rendering the substrate more suitable for other species (Neff, 2010). Furthermore, biodegradable organic additives in some WBFs may stimulate growth of microbial communities in sediments leading to a depletion of oxygen (Neff, 2010). These impacts associated with discharge accumulation would be mitigated by the strong currents and tidal range of Cook Inlet which will rapidly dilute and disperse the drilling fluids and cuttings (Neff, 2005).

Benthic communities impacted by the discharge of drilling fluids and cuttings recover quickly because sediment grain size and texture altered by the drilling fluids and cuttings rapidly return to pre-discharge conditions (Neff, 2010). Any organic matter in WBF will degrade rapidly allowing sediment oxygen concentrations to return to normal, although the rate of the recovery depends on the thickness of the drilling fluid and cuttings accumulations. While a study by Neff (2010) showed that the rate of recovery may be slightly slower in cold water than temperate environments, recovery would occur rapidly in the high-energy environment of Cook Inlet (Neff, 2005). Impacts from drilling discharges would be localized to the benthos immediately around the drilling area and communities are expected to recover quickly, resulting in minor impacts to lower trophic organisms.

4.3.4.3. Other Operational Discharges

Not including drilling discharges (see Section 4.2.2), the major waste discharges produced during drilling include bilge, ballast, fire and cooling water; sanitary and domestic wastes; and deck drainage (Section 4.2.3); Table 4.2-2 shows which development phases involve these discharges. These discharges are also regulated under the terms of NPDES permits to minimize negative impacts of potentially contaminated discharges on the surrounding environment. Currently, General Permit AKG-28-5100 authorizes discharges of sanitary and domestic wastes, bilge and ballast water, and other non-drilling operational discharges from exploration facilities, but does not authorize discharges from development or production facilities. General Permit AKG 31-5000 authorizes discharges from development and production facilities with the exception of drilling fluids, cuttings, produced water, and produced sand.

Within marine waters, routine discharges would occur from platforms, drilling vessels, and supply and service/construction vessels as part of normal operations, and could contribute to degradation of water quality and plankton communities. However, on platforms and drilling vessels, sanitary and domestic waste would be processed routinely through on-site USCG-approved MSDs before being discharged overboard or contained until they can be disposed of at proper onshore facilities. Similarly, deck drainage as well as bilge, ballast, and fire water would be treated on site to remove oil and other contaminants prior to discharge per USCG regulations. Waste recovered from the treatment processes would be containerized and shipped to shore for disposal. Cooling water discharge is regulated through NPDES permits as established by Section 316(b) of the CWA (see Section 4.2.4 for additional information). Routine discharges introduced into Cook Inlet waters by oil and gas activities would be diluted and dispersed by currents associated with the tides (diurnal tidal variations at the upper end of Cook Inlet at Anchorage can be 9 m (30 ft)) (Saupe, Gendron, and Dasher, 2005). Additionally, compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters by removing pollutants prior to water discharge. Therefore, once discharged, mixing, dilution, and dispersion of the wastes with large volumes of water would occur and any impacts on plankton communities would be highly localized and temporary, resulting in a minor impacts designation.

4.3.4.4. Water Intake

Water intake under the Proposed Action will result from withdrawing seawater for once-through, non-contact cooling of machinery on the drilling rigs as described in Section 4.2.4. Table 4.2-2 shows which development phases involve water intake. Cooling water withdrawal could occur during the production phase. Withdrawal amounts would depend on number and types of offshore structures requiring cooling water intakes.

Phytoplankton and zooplankton can be sucked (entrained) into the heat exchanger and eventually discharged from the system. Entrained organisms pass through the cooling system where they are exposed to pressure changes, thermal shock, and antifouling chemicals such as chlorine. At the population level, these impacts can affect threatened or endangered species or reduce ecologically critical organisms within the food web (40 CFR 122 and 125). Once-through cooling systems can cause various adverse impacts on plankton communities, including decreased biomass and productivity of entrained heterotrophic bacteria and phytoplankton, reduced survival of entrained zooplankton and other metazoans, and reduced diversity of the zooplankton community (Choi et al., 2012). The EPA estimates that hundreds of billions of plankton, fish eggs, and larvae are lost every year as a result of impingement or entrainment for cooling water withdrawals across all applicable industries (EPA, 2013c).

Discharged cooling water may range from 10°C to 15°C warmer than the surrounding seawater (EPA, 2009). The temperature difference can accumulate in the vicinity of the discharge if the vessel or structure is stationary (e.g., a vessel in port, a gas platform, a drillship) resulting in localized warming of the water. However, the warm water would rapidly dilute, mixing to background temperature levels within the high-energy environment of Cook Inlet.

Section 316(b) of the CWA requires NPDES permits to ensure that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available to minimize adverse environmental impact from entrainment of aquatic organisms. A variety of methods to minimize impingement and entrainment are available, including reduced water flow and technological controls designed to decrease mortality of organisms less than 0.56 inches. The final NPDES permit for Cook Inlet incorporates these regulations, including requirements for intake water to be drawn at <0.2 m/s (0.5 ft/s) and use of the most current technology to minimize impingement and entrainment. Adherence to permitting regulations will minimize the effect of water intake structures on plankton and fish larvae. These effects would be minor, as they would be localized and less than severe.

4.3.4.5. Physical Presence, Including Lights

The IPF description presented in Section 4.2.7 identifies structures (i.e., MODUs and platforms), vessels, and pipelines that can attract marine life. Vessel traffic associated with the Proposed Action is expected to have negligible effects on plankton, which are present throughout the proposed Lease Sale Area, and to have negligible effect on lower trophic organisms. Table 4.2-2 shows which development phases involve the physical presence IPF. All offshore vessels and structures maintain exterior navigation lighting for navigational and aviation safety, and special use lighting in accordance with Federal regulations. Artificial lighting and flaring of gas may attract and directly or indirectly impact lower tropic level organisms.

Petroleum platforms have exterior floodlights that assist in nighttime operations and aid navigation. These lights illuminate surrounding waters and could attract phototactic organisms (Keenan, Benfield, and Blackburn, 2007). Keenan, Benfield, and Blackburn (2007) quantified the underwater irradiance at two offshore petroleum platforms illuminated predominantly by natural gas flares and floodlights. Results indicated that light levels near platforms were 10 to 1,000 times higher than at control sites. Keenan, Benfield, and Blackburn (2007) concluded that platforms provide an enhanced foraging environment for larval fish (as well as juveniles and adults) by providing sufficient light to locate and capture prey as well as by attracting and concentrating positively phototaxic prey.

Lighting from offshore vessels and drilling operations will be transient and localized, and will have nominal impacts on plankton communities. The E&D Scenario assumes that two to three production platforms will be installed in Cook Inlet. Platforms illuminate a small volume of water in the area, thus increased light irradiance would be localized but of a long duration. Platforms will eventually be decommissioned and light levels from the platform would return to normal upon their removal. The localized and temporary effects of platform lighting would be minor.

4.3.4.6. Accidental Oil Spills and Gas Release

Benthic and planktonic invertebrates are exposed to oil in different ways and vary in their ability to avoid exposure (Blackburn et al., 2014). Potential impacts to lower trophic level organisms related to accidental spills include the following:

- Direct toxic effects, including lethal (mortality) or sublethal effects such as impacts on behavior, reproduction, growth and development, immune response, and respiration (e.g., Auffret et al., 2004; Bellas et al., 2013; Blackburn et al., 2014; Hannam et al., 2010)
- Indirect toxic effects, including the inhibition of air-sea gas exchanges and hypoxia from the degradation of oil (Abbriano et al., 2011; Blackburn et al., 2014; Ozhan, Parsons, Bargu, 2014)
- Physical smothering and reduced photosynthesis (Blackburn et al., 2014; González et al., 2013; Ozhan, Parsons, Bargu, 2014); and
- Biomagnification/bioaccumulation of pollutants up food webs (Blackburn et al., 2014)

As shown in Tables 4.2-1 and 4.2-2, accidental spills could affect all resources during all phases of the scenario (i.e., exploration, development, production, decommissioning), depending on the spill type, source, and spill size (volume).

Accidental events could include small (<1,000 bbl) spills and up to one large (≥1,000) spill stemming from fuel transfer accidents, platform fuel tank ruptures, loss of well control of gas, and from platforms, MODUs, and pipelines. The magnitude and extent of impacts on lower trophic level organisms from such spills will be a function of a variety of factors, including (1) the time of year of the spill, (2) the volume of the spill, (3) the type of product spilled, (4) environmental conditions at the time of the spill, (5) the habitats exposed to the spill, (6) the feeding mode of species exposed to the spill, and (7) ability of a species to process ingested contaminants. Of particular importance is the habitat exposed to the spill. The two fundamental types of marine habitats are the water column and the benthos, where invertebrates are dominant inhabitants.

Oil released from a wellhead (subsurface release; blowout) or from a drilling rig or vessel (surface release) will affect plankton communities because they have no or limited ability to avoid contact with oil. Direct contact with oil will result in the uptake of toxic fractions, physical smothering, and possibly mortality for large numbers of organisms (Blackburn et al., 2014). Results of post-spill studies of plankton communities following the *Deepwater Horizon* spill showed that oil and the biodegradation of oil can lead to indirect impacts such as inhibition of air-sea gas exchanges, reduced light penetration, and hypoxia resulting from accelerated hydrocarbon degradation (Abbriano et al., 2011; Blackburn et al., 2015; Ozhan, Parsons, Bargu, 2014).

Mortality of zooplankton has been shown to be positively correlated with oil concentrations (Lennuk et al., 2015). Spills that are not immediately lethal can have short- or long-term impacts on biomass and community composition, behavior, reproduction, feeding, growth and development, immune response, and respiration (Auffret et al., 2004; Bellas et al., 2013; Blackburn et al., 2014; Hannam et al., 2010; Harvell et al., 1999; Wootton et al., 2003). Zooplankton are especially vulnerable to acute crude oil pollution, showing increased mortality and sublethal changes in physiological activities (e.g., egg production) (Lee, Winters, and Nicol, 1978; Linden, 1976; Moore and Dwyer, 1974; Suchanek, 1993). Zooplankton may also accumulate PAHs through diffusion from surrounding waters, direct ingestion of micro-droplets, (e.g., Berrojalbiz et al., 2009; Lee, Koster, and Paffenhofer, 2012; Lee, 2013), and by ingestion of droplets that are attached to phytoplankton (Almeda et al., 2013a,b). Bioaccumulation of hydrocarbons can lead to additional impacts on higher trophic level consumers that rely on zooplankton as a food source (Almeda et al., 2013a,b; Blackburn et al., 2014).

Oil spill impacts to phytoplankton include changes in community structure and increases in biomass, which have been attributed to the effects of oil contamination and decreased predation due to zooplankton mortality (Abbriano et al., 2011; Ozhan, Parsons, Bargu, 2014). Ozhan, Parsons, Bargu (2014) reported that the formation of oil films (or slicks) on the water surface can limit gas exchange through the air-sea interface and can reduce light penetration into the water column by up to 90%, which will limit phytoplankton photosynthesis (González et al., 2013; Ozhan, Parsons, Bargu, 2014). The impact of an oil spill on phytoplankton is a complex issue. According to Ozhan, Parsons, Bargu (2014), different crude oils do not affect phytoplankton in identical ways because of the unique compositions of crude oils from different wells or regions. The toxicity of oil is affected by weathering and can be increased by the presence of dispersant and vary with temperature and light while the sensitivity of phytoplankton to oil toxicity may increase under nutrient limited conditions. Additionally, some phytoplankton species are more tolerant of oil exposure than others while some species are more tolerant under low concentrations and some under high concentrations. Phytoplankton populations can change quickly on small temporal and spatial scales making it difficult to predict how a phytoplankton community as a whole will respond to an oil spill. González et al. (2013) concluded that that the assessment of the impact of oil spills on phytoplankton communities should not be a priority of the environmental monitoring efforts after a spill since impacts can be very subtle or even undetectable.

The microbial community also can be affected by an offshore oil spill. Changes in the microbial community because of an oil spill could have substantial impacts on the rest of the marine ecosystem. However, several laboratory and field experiments and observations have shown that impacts to planktonic and marine microbial populations generally are short lived and do not affect all groups evenly, and in some cases stimulate growth of important species (González et al., 2009; Graham et al., 2010; Hing et al., 2011).

Zooplankton exposed to *Deepwater Horizon* oil typically exhibited decreases in feeding and reproduction as well as increases in mortality, while some phytoplankton species showed population growth (with low concentrations of oil) and others exhibited decreases in abundance (at higher concentrations of oil) (Abbriano et al., 2011; Ozhan, Parsons, Bargu, 2014). Recovery of planktonic communities from oil exposure can be affected by multiple factors. The two main factors are (1) the hydrodynamics of the habitat in which planktonic organisms are exposed, and (2) the planktonic community composition. The more current flow or mixing of the water column, tidal flushing, oceanic currents, wind driven wave energy, or upwelling events, the more dilution of the contaminates and less potential for exposure. Zooplankton communities from coastal habitats (i.e., inlets, estuaries, enclosed bays) with restricted hydrodynamics are considered more susceptible to long-term effects. Planktonic communities also have a higher capacity for recovery from the effects of oil spill pollution over the long term due to their short-life cycle and high reproductive capacity (Abbriano et al., 2011). Planktonic communities drift with water currents and recolonize from adjacent areas; these attributes and short life cycles of plankton facilitate relatively rapid recovery of the population following a disturbance. Several studies found that zooplankton communities reestablish several weeks to months after an oil spill, indicating a high capacity for recovery (Al-Yamani et al., 1993; Varela et al., 2006). Zooplankton effects (i.e., losses) can also be offset by the ability of some species to avoid oily patches (Trannum and Bakke, 2012).

The zooplankton community also contains free-floating embryos and larvae of invertebrates that inhabit the sediment as adults, including sea urchins, mollusks, and crustaceans. The planktonic stages of benthic invertebrates are more sensitive to pollutants than adults and their survival is critical to the long-term health of the adult populations (Anselmo et al., 2011; Bellas et al., 2013; Blackburn et al., 2014). The eggs and larvae of planktonic oysters exposed to oil show impaired development and decreased settlement of juveniles (Blackburn et al., 2014). A review of studies conducted after the *Prestige* oil tanker spill off the northwest coast of Spain by Blackburn et al. (2014) reported that sea urchin embryo development was inhibited by as much as 50% when fuel oil content in the water was >3.8%; that oil-polluted seawater collected from coastal sites was more toxic than contaminated sediment to embryos and larvae of bivalves and echinoderms; and that oil impaired growth of sea urchin and oyster larvae and development of mussel embryos.

Oil and its weathered byproducts bind and become buried in sediment resulting in long-term persistence in the environment, increasing exposure time of benthic invertebrates (Blackburn et al., 2014; Peterson et al., 2003; Short et al., 2004, 2007). Chronic exposure to oil and its byproducts can cause cellular damage and impair reproduction, growth, and development in marine invertebrates (Albers, 2003; Blackburn et al., 2014). Benthic invertebrates exposed to hydrocarbons for long periods may accumulate higher levels of hydrocarbons than pelagic organisms (Blackburn et al., 2014). Exposure to hydrocarbons is amplified for invertebrates that are part of the pelagic zooplankton as embryos and larvae, and live in the sediment as adults. These life habits potentially lead to an increased risk of long-term population-level impacts as these species are exposed to oil in multiple habitats and life stages (Blackburn et al., 2014).

Oil released from a wellhead (subsurface release; blowout) or from a drilling rig or vessel (surface release) will affect benthic communities as it washes ashore or as it sinks and becomes bound to sediments. Benthic invertebrates impacted by an oil spill can occur in habitats from the intertidal coastal areas to the deep sea; some are mobile, while others are sessile. Benthic invertebrates are susceptible to long-term exposure and can accumulate higher levels of sediment-bound contaminants (NRC, 2003b; Peterson et al., 2003).

Impacts of oil to benthic invertebrates vary depending on life history, feeding behavior, and ability of a species to metabolize toxins (Blackburn et al., 2014). Filter-feeding invertebrates such as mussels and oysters can ingest oiled organic particles, and can uptake oil dissolved in the water column where it then bioaccumulates in their tissues (NRC, 2003b,c). Conversely, populations of invertebrates living within the sediments (e.g., polychaetes, nematodes, oligochaetes) have been shown to increase in areas where low concentrations of hydrocarbons are found (Blackburn et al., 2014; Jewett et al., 1999). The varying responses of benthic invertebrates to oil can lead to long-term alterations in the structure and biodiversity of benthic communities (Carls and Harris, 2004; Jewett et al., 1999). Oil spills have been shown to result in a severe reduction or complete disappearance of amphipods and echinoderms, and their subsequent replacement by opportunistic polychaetes in oiled areas (Blackburn et al., 2014; Jewett et al., 1999). Hale et al. (2011) showed that deposit-feeding and burrowing benthic invertebrates are impacted by chronic exposure to hydrocarbons in polluted sediments and their populations can continue to fluctuate as they respond by building shallower burrows to avoid sediment-bound oil, leading to greater exposure on the surface, reduced mobility, and increased susceptibility to predation (Blackburn et al., 2014). A study by Auffret et al. (2004) analyzed impacts to oysters from an oil spill and reported that one year after the spill, severe immunological alterations were observed in a site heavily impacted by oil, suggesting that chronic contamination - possibly generated by oil trapped in the sediments - had induced immunotoxicity. Bellas et al. (2013) studied the impacts of weathered oil on sea urchins and mussels, and showed a progressive increase in oil toxicity with weathering over 80 days.

Blackburn et al. (2014) conducted a literature review of oil spill impacts to various invertebrates and reported the following findings:

- Echinoderms (e.g., sea urchins, sea stars, sea cucumbers) can be particularly sensitive to oil with spills resulting in mass die-offs and strandings of adult sea urchins and sea stars. Early planktonic life stages exposed to oil may show impaired embryogenesis and larval growth.
- Mollusks (e.g., mussels, oysters, snails) are highly sensitive to oil. Oil ingestion through filter-feeding results in bioaccumulation of hydrocarbons. The limited capacity of this group to metabolize oil leads to prolonged exposure and negatively impacts feeding, growth, reproduction, embryo development, and immune response. Snails and limpets in intertidal rocky shores and estuaries have shown high levels of mortality after oil spills and reduced recruitment of juveniles for years afterwards, and sublethal concentrations impair their mobility, foraging behavior, and reproduction.
- Crustaceans (e.g., crabs, amphipods, lobsters, shrimp) suffer substantially reduced populations and strandings after oil spills. Crustaceans can be exposed to oil that is buried in sediments for long periods of time, and chronic exposure can impair feeding, mobility, development, and reproduction.
- Polychaetes display complex and varied responses to oil pollution, including increases in abundance following the mortality of other invertebrates, rapid colonization of damaged habitat, and mortality resulting in reduced populations.

Small Oil Spills (<1,000 bbl)

The magnitude and severity of impacts would depend on the spill location and size, type of product spilled, and environmental conditions at the time of the spill. The majority of the estimated small accidental spills would be <50 bbl, would quickly dissipate, and could affect a very small area for a short duration. Small spills >50 bbl but <500 bbl also would be relatively easy to contain and would affect small areas. A large spill (≥1,000 bbl), depending on the season and location, would be more difficult to contain and may result in lethal and sublethal effects on relatively large numbers of lower trophic level organisms (see the next section).

Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within the first 24 hours, although there is the potential for a small proportion of the heavier fuel components to adhere to PM in the upper portion of the water column and sink. Small spills of crude oil would persist longer in the environment and could result in larger impacts than spills of refined products.

Small spills could impact localized concentrations of planktonic organisms in the short term through acute toxic effects. Oil from surface spills can sometimes penetrate the water column by natural dispersion to 20 m (66 ft) or more; however, at these depths, the concentrations of the various chemical components of spilled oil are typically several orders of magnitude lower than those demonstrated to have an effect on marine organisms (NRC, 2003b,c). Therefore, it is likely that only low concentrations of oil from small surface spills would reach benthic habitats (NRC, 2003b,c). Impacts to benthic communities are not anticipated from small spills unless they occur near shore.

Overall, oil in open water can cause immediate mortality in zooplankton. In addition, because zooplankton includes immature stages of invertebrates that inhabit benthic habitats as adults, mortality may result in long-term decreases in abundance and changes in community composition. These early life stages are more sensitive to oil compared to adults, and thus zooplankton mortality has implications for recruitment of juveniles into existing adult populations. To compound the situation, benthic invertebrates also are affected adversely as adults by oil that is trapped and buried in sediments as well as mussel and oyster beds, where it can persist long-term.

Small spills would not have population level impacts and would impact relatively few habitats. Estimated small accidental oil spills could impact lower trophic level organisms and these impacts would be unavoidable. The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the activity/accident; however, small spills would be expected to result in short-term minor impacts to small areas.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. The magnitude and severity of impacts would depend on the spill location and size, type of product spilled, and environmental conditions at the time of the spill. Large spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within the first 24 hours, although a small proportion of the heavier fuel components could adhere to PM in the upper portion of the water column and sink. Large spills of crude oil would persist longer in the environment and could result in more greater impacts than spills of refined products.

A large spill (≥1,000 bbl), depending on the season and location, could be difficult to contain and might result in moderate habitat impacts, including lethal and sublethal effects on relatively large numbers of lower trophic level organisms, described below in more detail. For large spills, BOEM conducted an OSRA, which estimates the areas potentially contacted and the probability of these areas to be contacted, assuming a large spill occurs. The OSRA also factors in the chance of one or more large spills occurring and contacting.

A large gas release and ensuing explosion and fire would kill any lower trophic level organisms in the immediate vicinity in summer or winter. Blowouts of natural gas condensates that did not burn would disperse very rapidly at the blowout site; thus, it is unlikely that toxic fumes would affect lower trophic level organisms, except those very near the blowout source. Overall, mortality associated with a blowout is expected to have short-term minor effects on Cook Inlet's lower trophic level organisms.

Oil-spill Risk Analysis

Lower trophic level organisms in Cook Inlet and the surrounding region are represented in the OSRA model by ERAs, LSs, and GLSs listed in Table A.1-13 of Appendix A. A summary of the highest percent chance that a large oil spill will contact these lower trophic level resources within 3 and 30 days during summer and winter assuming a large spill occurs is provided in Table 4.3.2-6.

Table 4.3.2-6. Highest Percent Chance of a Large Oil Spill Contacting Lower Trophic Level Resources[1]

OSRA Feature Type	Highest Chance of Contact	Summer		Winter	
		3 days	30 days[2]	3 days	30 days[2]
Environmental Resource Area (ERA)	≥0.5–<6	155 (Barren Islands)	--	155 (Barren Islands)	--
	≥6–<25	154 (Chinitnat Bay)	154 (Chinitna Bay) 155 (Barren Islands)	154 (Chinitna Bay)	154 (Chinitna Bay), 155 (Barren Islands)
	≥50	11 (Augustine), 153 (Polly Creek Beach)	11 (Augustine), 153 (Polly Creek Beach)	11 (Augustine), 153 (Polly Creek Beach)	11 (Augustine), 153 (Polly Creek Beach)
Grouped Land Segment (GLS)	≥0.5–<6	--	--	129 (Redoubt Bay), 136 (West Kenai), 137 (West Kenai), 138 (Kachemak Bay State Park), 140 (West Kenai)	125 (Kukak Bay), 129 (Redoubt Bay), 131 (Trading Bay), 136 (West Kenai), 137 (West Kenai), 140 (West Kenai), 160 (Kodiak)
	≥6–<25	138 (Clam Gulch Critical Habitat)	138 (Clam Gulch Critical Habitat)	--	138 (Clam Gulch Critical Habitat), 155 (Afognak), 157 (Afognak)

Notes: -- all percent chances of contact are <0.5.
[1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5 are shown.
[2] Note that the highest percent chance of contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.
Source: Appendix A (Tables A.1-13, A.2-22, A.2-24, A.2-27, A.2-29, A.2-32, A.2-34, A.2-42, A.2-44, A.2-47, A.2-49, A.2-52, and A.2-54). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

Table 4.3.2-6 shows that Augustine (ERA 11) and Polly Creek Beach (ERA 153) have the highest chance (≥50%) of being contacted by a large spill during summer and winter months. Augustine Island is an important area for clams, scallops, and seagrass; Polly Creek Beach is an important area for clams and seagrass. Depending on the source and location of the spill, the percent chance that a large spill will contact one of these areas after 30 days is ≥50%. Because the percent chance of contact with other areas is low (<25%), these areas are not considered to be at risk. However, the remaining areas listed are important harvest areas for clams and crabs.

Table 4.3.2-6 shows the ERAs, LSs, and GLSs that have the highest chance of contact by a large oil spill; within 30 days, it is estimated that weathering processes over that period would reduce the amount of oil remaining on the sea surface to 24% of the initial volume of the spill in the summer and to 3% of the initial volume of the spill in the winter (Appendix A Table A.1-28).

As shown in Appendix A, Table A.2-61, for Polly Creek Beach (ERA 153), the highest combined probability within 30 days is 12%. The combined probability of one or more large spills occurring and contacting ERAs 11, 154, and 155 is <8% within 30 days over the life of the Proposed Action. Appendix A, Table A.2-63, shows that the highest combined probability within 30 days for the Clam Gulch Critical Habitat (GLS 138) is <1%.

The summer months are a period of peak primary productivity in Cook Inlet (see Section 3.2.1), and a large spill at the sea surface under the Proposed Action would result in mortality of plankton in the surface layer, but there likely would be little mixing into subsurface waters or in the benthos. The toxicity of a surface slick likely would decrease rapidly because of evaporation, dispersion, and dilution and have little effect on plankton overall. Because the summer months are the most productive time of year, the effect on plankton populations would not be measureable for long because of the rapid rate of production; phytoplankton and zooplankton populations are capable of doubling their biomasses within a few days and a couple of weeks, respectively.

The likelihood of an oil spill contacting part of the shoreline is relatively high in Cook Inlet because it is an estuary mostly surrounded by shoreline. Oil contacting the intertidal and subtidal zones will impact benthic invertebrates, resulting in lethal impacts as well as sublethal effects, including adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (e.g., feeding, mating, habitat selection). Planktonic invertebrates are not likely to be contacted by an oil spill in subtidal areas, except for floating larval forms, which may be contacted anywhere near the surface.

Large spills under the Proposed Action could affect the water column and benthic habitats offshore and along areas of coastline resulting in mortality of plankton and benthic communities. Depending on timing, duration, size, and location of a large spill, population-level impacts are not likely for plankton or benthic invertebrates, but a spill in the winter will result in a longer recovery period for plankton. Regardless of season, oil reaching the shoreline will result in long-term persistent impacts to benthic invertebrates in the oiled area. A large spill could affect habitats along extensive areas of coastline, large numbers of benthic invertebrates, and important habitats for clams, scallops, and seagrass. Heavy oiling through direct contact with a spill would likely result in mortality, while lightly oiled lower trophic level organisms may experience a variety of lethal or sublethal effects; with some species experiencing increases in abundance. Overall, impacts to lower tropic level organisms from a large spill would be moderate and would depend on the timing, location, and environmental conditions affecting weathering of the oil

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations.

Planktonic organisms, such as zooplankton (including fish and invertebrate larvae) and phytoplankton, may be affected by mechanical recovery of spilled material, as they are located in the water column and are generally unable to move away from oil without a current, which would carry the spilled material with it. Physical damage from containment and collection procedures could also occur. These effects of mechanical recovery would be short-term and localized to the spill area. Benthic organisms would not likely be affected by mechanical recovery activities occurring at the surface. The effects of mechanical recovery on lower trophic organisms would be minor.

In-situ burning of spilled oil is used to remove oil from the surface and would impact lower trophic organisms in the immediate area due to increased water temperature and residue from the burn sinking to the bottom. Death of planktonic organisms is expected in the area of the burn. At the seafloor, residue from a burn can sink and smother benthic organisms. These effects are expected to be short-term and localized to the immediate burn area, and would be considered minor.

The use of dispersants could result in impacts on plankton communities. Ramachandran et al. (2004) suggested that the use of oil dispersants will increase the exposure of fish eggs and larvae to hydrocarbons in crude oil. Results in a study by Ortman et al. (2012) suggested that the addition of dispersant and dispersed oil to northern Gulf of Mexico waters in 2010 may have reduced the flow of carbon to higher trophic levels, leading to a decrease in the production of zooplankton and fish on the Alabama shelf. A review by Lee et al. (2012) found that plankton communities (mainly represented by copepod studies) were impacted more severely by dispersant plus crude oil than by crude oil alone. Trannum and Bakke (2012) reported that carbon from oil and oil degradation (from dispersants) was incorporated into the planktonic food web and detected in two different plankton size classes. Almeda et al. (2013) reported that dispersants and dispersant-treated oil were 2.3 and 3.4 times more toxic, respectively, than crude oil alone to mesozooplankton and that UVB radiation increased the lethal effects of dispersed crude oil in mesozooplankton communities by 35%. Dispersed oil would also have toxic effects to benthic communities, as described previously for oil spill impacts.

Spill impacts and cleanup operations will be influenced by time of year in Cook Inlet. An oil spill occurring into ice may persist for a longer period of time than during ice-free conditions (Buist et al., 2008; Payne, McNabb, and Clayton, 1991). Under calm conditions and cold temperatures in restricted waters, vertical mixing and dissolution would be reduced (Buist et al., 2008). A large spill occurring on or under ice would be trapped and persist until the ice melted, allowing the spill to disperse (Drozdowski et al., 2011), and trapped oil can be transported by currents to areas more distant from the site of the accidental spill. Volatile components of the spill would be more likely to freeze into the ice rather than evaporate. Response efforts would be hindered and aided by the presence of ice. Ice will contain a spill (reduce spreading), concentrate it, and act as a barrier to shoreline oiling. However, ice also will make a spill difficult to detect, locate, and access. Natural processes would aid the degradation of the oil and gas released during a large spill, but at a slower rate than in warmer waters.

These effects could be long-lasting and widespread for both the plankton and benthic communities if a large spill occurs, while a small spill would be more localized. Effects are unlikely to be population-level, though, as planktonic communities can quickly recover, and benthic community impact would be limited spatially by the settling of oil and dispersant. Depending on the size of the spill and the time of year, use of dispersants could have minor (small spill) to moderate (large spill) effects on lower trophic communities.

Increased vessel traffic would add noise to the environment, and would increase the chance of small discharges from response vessels. Effects to the lower trophic communities would be extremely short-term and would have negligible impact overall.

4.3.4.7. Impact Conclusions

The nature and magnitude of effects of routine operations in the proposed Lease Sale Area on lower trophic level organisms would depend on the specific location, timing, nature, and magnitude of the operation. For routine activities, the primary effects would be seafloor disturbance of benthic communities from structure emplacement and intake of plankton communities during water intake to cool machinery.

In general, routine operations associated with the E&D Scenario are not expected to result in population-level effects on benthic or planktonic communities. Most impacts from routine operations would be localized to the site of the project infrastructure or along support vehicle routes, be short-term or transient for most operations, and likely affect relatively small areas. Additionally, lessees and their contractors will be expected to comply with NPDES permit requirements and USCG regulations to reduce or prevent impacts on receiving waters caused by routine discharges from normal operations, and any permitted discharges are expected to dilute and disperse rapidly in the water column.

The benthic community has been shown to recover from structure emplacement after one year (Manoukian et al., 2010) and to recover rapidly from the discharge of drilling fluids and cuttings (Neff, 2010; Ellis, Fraser, and Russell, 2012). A study by Neff (2005) indicated that little drilling waste accumulates on the seafloor, dilution occurs very quickly in the high-energy environment of Cook Inlet, and adverse effects of the discharges cannot be detected. Additionally, Arctic planktonic and benthic communities are well adapted to seasonal disturbance and recover rapidly from the brief and intermittent disturbances associated with drilling operations (Neff, 2010; Ellis, Fraser, and Russell, 2012). Other operational discharges will be mixed, diluted, and dispersed in large volumes of water once discharged and compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters. Impacts from water intake on plankton communities will be minimized by NPDES requirements ensuring that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available to minimize adverse environmental impact from entrainment of aquatic organisms. Finally, impacts to plankton communities from lighting on offshore structures would be localized to the area of the structure and temporary aside from areas directly in the vicinity of the two to three platforms that will be installed, and not result in population-level effects. The overall impact of routine operations of the Proposed Action on lower trophic level organisms would be temporary and localized and is expected to be **minor**.

Accidental oil spills, including small spills and up to one large spill, stemming from fuel transfer accidents, platform fuel tank ruptures, loss of well control releasing gas, and from platforms, MODUs, and pipelines could occur under the Proposed Action. The magnitude and extent of impacts on lower trophic level organisms from such spills would depend on a variety of factors (e.g., time of year). While most accidental spills would be small and have relatively small impacts on lower trophic level organisms, large spills that reach coastal areas could have more persistent impacts to benthic invertebrates and could require remediation. Impacts from a large spill could result from oiling of the shoreline, additional impacts to plankton from the use of dispersants, and mechanical damage during the cleanup process. Overall, impacts from accidental spills to lower trophic level organisms would not be sustained at a population level, and are expected to be **minor** for small, localized, spills and **moderate** for a large spill. Oil spill response practices described in Section 4.2.14.3 would have **minor** impacts for routine activities and **minor** to **moderate** impacts for accidental spills. Also, GIUE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for lower trophic communities for routine activities.

4.3.5. Fish and Shellfish

Fisheries resources (i.e., pelagic finfish, ground finfish, and shellfish) in the proposed Lease Sale Area are described in Section 3.2.2. This section discusses effects on fish and shellfish that would occur as a result of all phases of oil and gas activities in the proposed Lease Sale Area and adjacent marine waters. The IPFs addressed in this section include more than the BOEM 2017-2022 Draft Programmatic EIS (USDOI, BOEM, 2016), such as seafloor disturbance, drilling discharges, other operational discharges, water intake, underwater noise, physical presence, trash and debris, and accidental spills. The analysis considers the potential for population-level impacts; with population defined here as a monospecific group of organisms occupying the proposed Lease Sale Area or nearby areas.

Routine activities associated with this alternative that may adversely affect fish and shellfish include seafloor disturbance and habitat alteration; permitted drilling discharges; seismic surveys; trash and debris (including non-hazardous domestic waste); and offshore construction, physical presence, and decommissioning activities. Small (<1,000 bbl) and large (≥1,000 bbl) accidental spills may affect fisheries resources.

4.3.5.1. Seafloor Disturbance and Habitat Alteration

Seafloor disturbance as well as fish and shellfish habitat alteration would likely occur during the exploration, development, and decommission phases. Expected seafloor disturbance as a result of the

Proposed Action is described in Section 4.2.1. The placement of bottom-founded structures can affect benthic fish and shellfish resources in several ways. The primary impact factors are sediment disturbance and decreased visibility in demersal waters, increased turbidity due to suspension of sediments, loss of benthic habitat, and injury or mortality of the benthos (e.g., groundfish and shellfish). The magnitude of any damage to the seafloor would depend mainly on where the action occurs. For example, impacts from anchors depend on whether an anchor drags and what an anchor might drag across. Anchors may not hold fast under some conditions and may drag across the seafloor, damaging fish habitat and prey for fish, particularly sessile organisms. Vessels weighing anchor may also crush or injure groundfish and/or crustaceans during operations. Seafloor disturbance is not expected to affect the upper mid- to upper water column, depending on the depth of the water.

The mooring lines from MODUs could sweep along the seafloor, scouring the bottom. Excessive scope (length) and movement of a mooring chain could disturb a much larger area of the seafloor than would an anchor alone, depending on the prevailing wind and current directions. If mooring lines of steel, chain, or synthetic polymer are anchored to the seafloor, areas around the structure can be directly affected by their emplacement. Scouring would create small localized turbidity plumes, most likely causing an avoidance response in benthic and pelagic species. The disturbance to the benthic community from sweeping anchor components would be the primary long-term adverse impact to the bottom habitat.

Increased turbidity would manifest as a small and temporary impact. Increased turbidity would cause a direct adverse impact on water quality (see Section 4.3.2) as well as direct and indirect adverse impacts on benthic fish and shellfish, including groundfish and crabs. The degree of increased turbidity resulting from exploration would depend on the equipment used, sediment grain size and settling rates, and bottom currents. Models of tidal currents in Cook Inlet predict current speeds range from approximately 2 to 4 m/s (approximately 3.8 to 7.7 kn), generally flowing in a north-south direction. Based on this velocity and flow, suspended sediments would be removed from the area of impact almost immediately, reducing the level of impact on benthic fish and shellfish.

Direct impacts from the placement of these exploratory components would include crushing individuals located under the footprint, particularly benthic infaunal species such as razor clam and Pacific weathervane scallop. For example, these species could be injured or killed by direct contact with sweeping mooring lines. More mobile crustaceans such as crabs and benthic fish would be able to avoid impacts from the sweeping mooring lines, and likely would leave the disturbed area. This disruption of benthic shellfish assemblages could indirectly affect bottom-feeding fishes by reducing the available prey base. Pelagic and soft bottom demersal fishes may move out of an area because of an installation activity. Depending on the amount of disturbance, displaced fishes may or may not return.

Because the exploration and delineation well drilling operations in Cook Inlet are expected to range between 30 and 60 days per well at different locations, the impacts from the mooring lines would be short-term. Therefore, it is likely that the benthic community would recover or recolonize once drilling activities are completed in an area.

The direct impacts to the seafloor habitat disturbed or crushed by anchoring and drilling rig legs would be small compared to the total area of benthic habitat available in the proposed Lease Sale Area. Placement of MODU components also likely would cause an increase in local short-term turbidity, which could increase stress levels and scour or abrade the gills of crustaceans and groundfish in the near vicinity. Habitat of sessile organisms and demersal fish larvae could be covered by a turbidity plume and might smother some organisms. However, short-term effects on the seafloor habitat from turbidity created during exploratory activities are considered low, especially because Cook Inlet waters are naturally high in suspended sediments.

Short-term minor adverse impacts would be expected to the seafloor habitat from geotechnical surveys and exploratory well drilling. Negative impacts would include temporary loss of soft bottom habitat in and around the exploration activities due to increased turbidity and sediment deposition.

Similar to impacts discussed for exploratory efforts, disturbance associated with the installation of platforms during development include physical compaction or crushing beneath the structure or mooring lines, and the resuspension and settlement of sediment caused by structure emplacement. Movement of floating facilities also would move mooring lines in their arrays. Small areas of the seafloor likely would be affected by this kind of movement.

Construction activities are most likely to affect groundfish and shellfish that prefer soft substrate habitat in deeper water. Any disturbance or displacement would be localized and short-term (hours to months), limited to the time of construction and shortly thereafter. Effects would be limited to relatively few individuals in the immediate vicinity of construction activities.

Installation of OCS platforms would directly affect shellfish in the immediate vicinity. Organisms in soft substrates (e.g., Pacific weathervane scallops) would be adversely affected; however, platforms would add hard substrate to the marine environment. In turn, long-term positive impacts may accrue because offshore structures provide refuges to some groundfish species and their prey following construction.

Similar to exploration activities, the anchoring of vessels supporting various development activities would cause some continuing bottom disturbance on a small scale and of short duration (hours to days).

Considerable localized mechanical damage that would be confined to the footprint of the production platform could be inflicted on the seafloor by routine drilling activities associated with the development wells. However, the physical disturbance by structures related to a drilling operation affects a small area of the seafloor in comparison to the size of the proposed Lease Sale Area, meaning that the direct and indirect impacts on benthic fish and shellfish resources would be limited.

It is estimated that placement of pipelines and flowlines disturbs between 0.5 and 1 ha (1.25 and 2.5 ac) of seafloor per kilometer of pipeline, with the range depending on whether trenching is required (Cranswick, 2001). Trenching of pipelines can decrease habitat diversity by removing epifauna, smoothing the bottom roughness, and removing taxa that produce burrows and pits. Pipeline construction also would result in temporary disturbances to the water column and seafloor in the form of increased turbidity and noise, which can affect prey, prey habitat, and fish habitat. Noise impacts are discussed in Section 4.3.5.5.

Offshore pipelines would either extend shoreward from a production platform or connect an auxiliary platform with a hub. The footprints would disturb or eliminate limited amounts of seafloor habitat for demersal species. Demersal species include all capelin life stages; early juvenile sablefish; all life stages of sculpin; Pacific cod; Pacific hake; Pacific halibut juveniles and adults; walleye pollock juveniles and adults; adult octopus; to a lesser extent, Atka mackerel; arrowtooth flounder; black rockfish; yellowfin sole juveniles; and lingcod.

Where subsoil conditions allow, trenching using a subsea trenching jet would occur. Trenching and pipe laying would take place during the spring/summer seasons (i.e., beginning of May to the end of September). Using a trenching jet during this time of the year would avoid spawning and migration of longfin smelt, Pacific herring, Pacific sand lance, eulachon, capelin, and numerous groundfish species, including halibut and Pacific cod. However, several adult salmonid species may be impacted as they migrate through Cook Inlet, returning to their natal streams from spring through October or later.

This pipeline installation would cause direct and indirect impacts to the seafloor similar to vessel anchoring described previously, but would do so on a much larger scale (i.e., the length of the pipeline). Though adverse impacts would be expected, they would remain temporary and localized to the area immediately surrounding the pipeline. The extent of the area affected could vary depending on where the platform is located; this could result in an increase or decrease in the length of the platform-to-coast offshore pipeline.

It is assumed a pipeline landfall would alter a few hectares of intertidal habitat. This development would displace some coastal organisms such as razor clams, but would have no measurable effect on local populations. Beyond the direct impact of the trenching jet, habitat of demersal fish larvae could be covered by the plume and would smother some organisms. Short-term (2 to 3 hours) direct effects from turbidity created during construction of an offshore pipeline are considered low, especially because Cook Inlet waters are naturally high in suspended sediments. Suspended sediments would dilute rapidly within the mixing zone by waters of Cook Inlet as they are swept past the discharge point by strong tidal currents.

Because the direct impact would be restricted to short-term localized areas of seafloor within a linear pipeline footprint, recolonization of infaunal shellfish (e.g., razor clams and scallops) is expected to occur rapidly (over one season) and not impact species at a population level. Once installed, the pipelines would be stationary and would not have any impacts on infaunal shellfish or demersal species dependent on the habitat. Long-term changes to the seafloor habitat due to pipeline construction can be likened to the type of effects some bottom trawling fishing gear produce, except that pipeline construction disturbances to the seafloor habitat would be considerably smaller in area due to a single pass during construction.

The long-term change to the seafloor habitat would affect fish whose habits are semi-demersal, living on the seafloor and in the main water column (1 to 200 m (3 to 656 ft) deep). Semi-pelagic and semi-demersal fish include walleye pollock juveniles and adults, northern rockfish juveniles and adults, capelin adults, and early juvenile sablefish. Disturbed fish habitats are likely to be recolonized within 3 years. Pelagic fishes may re-inhabit the pipeline corridor within hours to days after construction operations cease and the trenched areas have filled back in with material. The area affected over time is too limited to have measurable adverse effects to populations of fish and shellfish in the defined area.

Once infrastructure such as a pipeline or platform is in place, positive effects may accrue as offshore structures provide refuges to some species and their prey. No additional impacts to the seafloor habitat are expected during production, except for possible pipeline maintenance activities. Impacts to fish and shellfish from these production activities would be similar to impacts from seafloor disturbance discussed previously that could occur during exploration and development phases. Decommissioning activities that would disturb the seafloor include plugging wells, removal of seafloor equipment, decommissioning of offshore pipelines, and removal of platforms. Impacts to fish and shellfish from decommissioning activities would be similar to impacts discussed for and the development phase.

The increase in turbidity and habitat alteration associated with the Proposed Action would be temporary and localized to the drilling area. Population-level impacts are not expected to occur at any stage of the Proposed Action. Overall, seafloor disturbance and habitat alteration will have minor impacts on the fish and shellfish communities in the proposed Lease Sale Area.

4.3.5.2. Drilling Discharges

Drilling discharges would be produced during the exploration and development phases of the E&D Scenario. The discharge of drilling fluids and cuttings can result in varying degrees of change on the seafloor and affect feeding, nursery, and shelter habitat for various life stages of fish and shellfish species inhabiting benthic areas over most of the proposed Lease Sale Area. Exploration and construction activities may result in resuspension of fine-grained mineral particles, usually smaller than silt, in the water column. These suspended particulates can reduce light penetration and lower the rate of photosynthesis and primary production of the aquatic area, especially if particles are suspended for lengthy intervals (Hanson, Helvey, and Strach, 2003). The feeding behavior of shellfish, groundfish, and pelagic fish species may be altered, potentially leading to decreased growth rates if high levels of suspended particulates persist. The contents of the suspended material can react with the dissolved oxygen in the water and result in oxygen depletion. There is increasing evidence to indicate that fine particles in drilling wastes such as bentonite and barite can have detrimental effects on filter-feeding invertebrates and benthic fish through gill abrasion and clogging (Hurley and Ellis, 2004; Neff, 2005).

Based on laboratory studies of acute and chronic/sublethal toxicity of drilling fluids and field observations of rates of dilution of drilling fluids in the water column, Neff (1987) concluded that pelagic fish and shellfish will never be exposed to drilling fluids long enough and at sufficiently high concentrations to elicit any acute or sublethal responses. Strong-swimming demersal fish such as sablefish, walleye pollock, Atka mackerel, and Pacific hake that are exposed to plumes of drilling discharges in the upper water column may be capable of swimming away. Zooplankton (eggs, fry, and small prey) occurring in or entering the mixing zone during discharge of drilling fluids and cuttings may experience lethal and sublethal effects due to their limited motility if they are within 1 to 2 m (3.3 to 6.6 ft) of the discharge point, even when volumes of drilling fluids and cuttings are released at rates permitted by the EPA (500 to 1,000 bbl per hour, depending on water depth). Such lethal and sublethal effects most likely would result from physical damage or smothering by bulk constituents comprising drilling fluids and cuttings. These effects would be highly localized and temporary. Such minor mortality of eggs, larvae, and prey organisms is considered negligible to the population dynamics of fisheries resources in Cook Inlet.

Drilling fluids and cuttings may adversely affect bottom dwelling shellfish, such as weathervane scallops, and benthic fish such as rockfish, Pacific halibut, yellowfin sole, rock sole, and a number of other flatfishes. Where drilling fluid solids settle on the seafloor, there could be localized adverse impacts on the benthos and prey organisms through chemical toxicity, change in sediment texture, or burial. The severity of the impact of drilling fluids and cuttings on the benthos is directly related to the amount of material accumulating on the substrate, which in turn is related to the amount and physical characteristics of the materials being discharged, and to the environmental conditions at the time and site of discharge, such as current speed and water depth. In high-energy environments such as Cook Inlet, little drilling fluid and cuttings would be expected to accumulate, minimizing impacts on the benthos.

The zone of detection for drilling discharges can be up to 8 km (5 mi) from the drillsite (Neff, 2010), but the impacts to benthic shellfish such as weathervane scallops and razor clams typically is not detected at distances farther than 1 km (0.6 mi) from the discharge source (Hurley and Ellis, 2004). In Cook Inlet, the impacts of discharges of drilling fluids and cuttings may be very localized or patchy in distribution because the waters of Cook Inlet generally are vertically well-mixed and strongly influenced by the tidal cycle. In high-energy environments such as Cook Inlet, little drilling fluids and cuttings are likely to accumulate near wellsites because any depositions are quickly transported away by strong currents and dispersed over large areas, and thereby diluted to low concentration (Hannah and Drozdowski, 2005) (Section 4.2.2). The heaviest materials (e.g., barite particles and cuttings) accumulate closest to the discharge point, and the lighter drilling fluid components settle farther away. Sediment deposition during discharges and physical activities associated with the drilling operations likely would disturb and displace demersal fish and mobile shellfish from the immediate area. In some cases, discharge points may be located at or near the seafloor. If demersal fish and mobile shellfish such as shrimp and crabs are present at the time of discharge, they probably would be disturbed and displaced from the immediate vicinity of the discharge, within a radius ≤100 m (330 ft). Demersal fish and mobile shellfish may reoccupy the immediate drilling area within minutes to hours after drilling or discharging operations cease. Localized cutting piles resulting from deposition of the densest particles could smother benthic communities and result in artificial reef effects where the piles attract marine organisms and epifaunal animals such as crabs to colonize. These effects on benthic communities could cause indirect effects to fisheries resources by reducing the available prey base and foraging opportunities for predators.

Hurley and Ellis (2004) stated that drilling discharges and cuttings have minor effects on fish health. Juvenile and adult pelagic fishes (e.g., capelin, herring, walleye pollock, Atka mackerel, Pacific cod, Pacific hake) and demersal fishes (e.g., Pacific halibut, arrowtooth flounder, yellowfin sole) are not likely to incur acute (lethal) toxic effects from exposure to permitted discharges within the Federal mixing zone because the concentrations are of negligible toxicity based on EPA standards.

Environmental studies conducted at the Terra Nova offshore oil development have demonstrated that the biological effects of development drilling that has occurred over a 10-year period have been limited and, when they occurred, effects to benthic aquatic organisms were highly localized (Neff et al., 2014). The extensive Terra Nova dataset provides evidence of decreases in sediment contamination and recovery of benthos after drilling ceases in an area (Neff et al., 2014).

Overall, drilling discharges probably would have a minor localized and short-term effect on fish and shellfish inhabiting near the drilling discharge deposition. Long-term changes to benthic and demersal fish and shellfish habitats on the seafloor due to the drilling discharge are unlikely as the affected area will be too limited spatially and temporally to have measurable adverse effects to populations of fisheries resources in the proposed Lease Sale Area.

4.3.5.3. Other Operational Discharges

Other operational discharges from vessels and platforms such as bilge, ballast, fire system test, and cooling water; sanitary and domestic wastes; and deck drainage would be produced during the exploration, development, and production phases. Other discharges that could occur during exploration drilling such as boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater would be subject to guidelines and stipulations in the relevant NPDES permit, including no discharge of free oil. Details regarding estimated discharge amounts under the Proposed Action are presented in Section 4.2.3.

Pelagic fish near work vessels could be exposed to water quality degradation at localized surface and near-surface areas from particulate and contaminant discharges from vessel deck runoff. The type and degree of effect from these discharges would depend on the species, life stage, location of fish relative to the discharge, concentration of the discharge, and exposure time. There could be localized mortality of early life stages of fish (i.e., eggs, larvae, young of year) that are more vulnerable and sensitive to vessel discharges than adult fish due to their relative lack of mobility. Potential vessel discharges and deck runoff from seismic and support vessels would cause temporary water quality degradation at localized sites.

Production activities also can create operational discharges, including produced water, produced sand, and well treatment and completion fluids. Even at low concentrations that are not directly lethal, some contaminants can cause sublethal effects on sensory systems, growth, and behavior of fish and shellfish, or may be bioaccumulated (NOAA, 2010a). Produced water can contain formation water, injection water, treatment and completion fluids, and high levels of dissolved solids and minerals (USDOI, BOEM 2012a). Currently General Permit AKG-28-5100 authorizes discharges of sanitary and domestic wastes, bilge and ballast water, and other non-drilling operational discharges from exploration facilities, but does not authorize discharges from development wells or production facilities. Meanwhile, General Permit AKG 31-5000 authorizes discharges from development wells and production facilities exclusive of drilling fluids, cuttings, produced water, and produced sand from new facilities. It is not expected that drilling fluids, cuttings, produced water, or produced sand will be discharged during development drilling or production activities.

Other discharges that could occur during drilling include well treatment fluids, workover or completion fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater would be subject to guidelines and stipulations in the relevant NPDES permit, including no discharge of free oil.

Operational discharges will have local and short-term effects on subpopulations of fish and shellfish inhabiting waters near the discharge location. Impacts to fish and shellfish exposed to other operational discharge range from superficial exposure to ingestion and related effects. Long-term changes to the benthic and demersal fish and shellfish seafloor habitats due to the drilling discharges are unlikely and overall impacts to fisheries resources would be minor.

4.3.5.4. Water Intake

Water intake likely would occur during the exploration and development phases, and, to a lesser extent, during the production phase (see Section 4.2.4). Withdrawal of estuarine and marine waters by water intake structures is a common industrial activity. Water intake systems are used for a variety of reasons, including ballast water, cooling water, drinking water, and industrial use. Normal ship operations as well as machinery on drilling rigs utilize intake structures for ballast water and engine cooling, and intake can result in impingement and entrainment of fish resources (Helvey, 1985).

Depending on the geographic location within Cook Inlet and the water depth of the intake pipe, phytoplankton, zooplankton, fish eggs, and juvenile fish can become trapped at the entrance screen to the cooling water intake and may become impinged, entrained, and killed (Hanson, White, and Li, 1977; Hanson, Helvey, and Strach, 2003).

Groundfish (e.g., Pacific hake, walleye, pollock) and shellfish (e.g., Pacific weathervane scallops, razor clams, king crab) eggs and larvae are an integral part of the zooplankton biomass in the upper layers of Cook Inlet. Some species spend a few weeks as free-floating zooplankton, while others such as Dungeness crab have zoea that spend up to a year as part of the zooplankton community. Fish eggs, larvae, and age-0 fish that pass through the hydraulic zone of influence of the water intake structure could be impinged or entrained, leading to injury or mortality. Groundfish early life stages and shellfish larvae would be particularly affected by water withdrawals.

A detailed 3D model was developed by Prakash, Kolluru, and Young (2014) to estimate the entrainment of zooplankton (fish eggs and larvae) and juvenile fish from an estuarine environment during the repeated short-term operation of a ballast water intake for an LNG carrier. The study assumed a withdrawal of approximately 8 million gallons of ballast water while at berth. The operations also assumed that one LNG carrier will call at the project every 2 to 3 days, resulting in approximately 150 ship calls per year or 12 per month. The modeling results indicated projected numbers of zooplankton and adult fish lost are very small (maximum of 0.12%), and that intake operations for ballast water likely would have very little effect on regional fish populations.

There are numerous entrainment studies for land-based power plants and ballast water for ships, but there have been very few studies conducted on offshore water intake impacts to fisheries resources. One such study analyzed zooplankton entrainment at four cooling water intake structure sites in the GOM (CSA Ocean Sciences Inc. and LGL Ecological Research Associates, 2014). The water column cooling water intake structure capacity was >7.5 million liters (2 million gallons) of seawater per day. Study results indicated that zooplankton densities in the Gulf of Mexico declined exponentially with total water depth as distance from the shoreline increased. Fish egg and larval densities at the deepest depth range sampled (200 to 300 m (656 to 984 ft)) were found to be a fraction of the densities at shallower depths. Relative to the daily zooplankton abundances passing each site, the level of entrainment was not biologically significant. This study determined that entrainment impacts were miniscule and that entrainment of zooplankton by cooling water intake structure would not have a noticeable or biologically significant impact (CSA Ocean Sciences Inc. and LGL Ecological Research Associates, 2014).

Potential disturbances and associated adverse impacts on the marine environment from water intakes have been reduced through the operating procedures required by regulatory agencies. Most of the activities associated with water intake are conducted under permits and regulations that minimize impacts to marine fish and shellfish. Section 316(b) of the CWA requires NPDES permits to ensure that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available to minimize adverse environmental impact from impingement and entrainment of aquatic organisms. The final NPDES permit for Cook Inlet incorporates regulations, including requirements for intake water velocity to be <0.2 m/s (0.5 ft/s); construction to minimize impingement and entrainment; accurate entrainment record keeping; and a biological study of source water. Overall adverse effects on fish and shellfish from water intake for once-through, non-contact cooling of machinery on the drilling rigs and for ballast water would be minimized and extremely localized due to the best management practices and NPDES permit requirements.

All life stages of various species of fish and shellfish in Cook Inlet would be affected by water withdrawals during all phases of activities. Adult pelagic fish would not be affected by water intakes because the burst speeds of adult fish are greater than the NPDES-regulated intake velocity of <0.2 m/s (0.5 ft/s) so that they can escape the zone of influence in front of the intake structure. The extent of the zone of influence is small relative to the water column. The increased velocity in front of the intake structure could impinge small weak swimming juvenile fish, but the effect would be negligible at the population level.

Water intake impacts could have short-term localized effects on juvenile fish, fish larvae, and shellfish larvae during the exploration, development, and production phases of the E&D Scenario. Fish eggs as well as fish and shellfish larvae are believed to be widely distributed in Cook Inlet, and water intakes are expected to be limited in spatial extent and frequency. Impacts to fish and shellfish as a result of entrainment in water intakes from ships and drilling rigs would probably have a minor localized effect on subpopulations of fish resources inhabiting the waters near the water intake structure.

4.3.5.5. Noise

Underwater noise would be produced during the exploration, development, production, and decommissioning phases. Physical and physiological, hearing impairment, and behavioral effects on fish and fish prey would occur at all water depths of the proposed Lease Sale Area. There could be chronic behavioral and physiological effects to fish at less intense sounds, and acute effects for individuals within a few meters of a sound source that is >180 dB, or at 50 to 90 dB above the hearing threshold of the fish species. Fish rely heavily on sensory perceptions of sound and pressure for many activities vital for survival, such as feeding, navigation, spatial orientation, predator avoidance, and communication. Fish possess hearing organs approximately comparable to other vertebrates, and also utilize a lateral line system that detects pressure waves near the individual. Combined, these two sensory systems provide fish with the ability to survive in their complicated underwater environment. A detailed description of noise expected during the Proposed Action is presented in Section 4.2.5.

Active Acoustic Sound Sources

Seismic surveys using airguns, water guns, or marine vibrators would happen during the exploration phase in the proposed Lease Sale Area. BOEM expects that the most likely type of survey will be a 3D survey focused on clusters of OCS blocks that have been identified as having a high potential for oil and gas resources based on existing seismic data. It is not expected that regional seismic surveys will be conducted over the entire proposed Lease Sale Area.

Airguns are the typical acoustic sound source for 2D and 3D deep-penetration seismic surveys; a water gun, sparker, pinger, or other source could be used for the geohazard surveys. Any acoustic source used during seismic exploration activities would ensonify the surface water, water column, seafloor habitats, and fish occupying those habitats. The effects would vary in time and space depending on the type of activity, the number of ongoing activities, 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.

Seismic surveys 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 (Purser and Radford, 2011; Radford et al., 2010; Slabbekoorn et al., 2010).

Comparison of sounds from airguns indicated that marine fish can hear airgun sounds (Pearson, Skalski, and Malme, 1992). The frequency spectra of seismic survey devices cover the range of frequencies detected by most marine fish (50 to 3,000 Hz) (Pearson et al., 1992). Marine fish are likely to detect airgun emissions nearly 2.7 to 63 km (1.6 to 39 mi) from their source, depending on water depth (Pearson, Skalski, and Malme, 1992). In a study investigating the effects of airguns on rockfish behavior, Pearson, Skalski, and Malme (1992) found the effects were evident as (1) shifts in the vertical distribution (up or down), (2) shifts in behavior, and (3) the occurrence of alarm and startle responses. Responses were species-specific. The threshold for startle responses was between 200 and 205 dB re 1 μPa @ 1 m; the general threshold for the alarm responses was approximately 180 dB re 1 μPa @ 1 m. Avoidance and other more subtle behavioral responses may occur, but limitations of the study enclosure prevented their expression.

Wardle et al. (2001) observed and tracked marine fishes (primarily adult mackerel, adult pollock, and juvenile cod) on an inshore reef before, during, and after an airgun array was deployed and repeatedly fired on site. The authors found that airgun emissions caused startle responses in all observed fishes to an observable range of 109 m (358 ft) from the sound source and an SPL of 195 dB re 1 μPa. One of two fish tracked at the reef during the study was found to react to airguns fired at a range of 10 m (33 ft), whereby the fish immediately moved away from the airgun to a range of 30 m (98 ft). Wardle et al. (2001) concluded that fish remained close to or in the region of the airguns continuing their normal activities. However, the study's timing of airgun firings (approximately one firing per minute) did not match airgun firings used by the offshore oil and gas industry, which typically emit an acoustic energy pulse every 7 to 16 seconds, creating a regular series of strong acoustic impulses separated by silent periods, depending on survey type and depth to the target formations.

Therefore, seismic surveys using an energy source to transmit energy into the subsurface and generate seismic waves can disturb and displace fishes and interrupt feeding (Pearson, Skalski, and Malme, 1992). However, information suggests that displacement of fish may be relative to the behavioral ecology of species involved (e.g., demersal versus pelagic). For example, inshore and reef fish species that are closely associated with live bottoms such as reefs are not easily displaced from their home areas (Wardle et al., 2001). Research suggests that some pelagic fish species leave the area during seismic surveys (Engås et al., 1996; Fewtrell and McCauley, 2012; Løkkeborg and Soldal, 1993). The change in distribution can lead to observations of catch increases in some areas and reductions in others (Løkkeborg, 1991). The areas apparently affected extended up to 33 km (20.5 mi) from the survey center.

While sounds from seismic sources may alter behavioral ecology, they also can directly impact a species physiology. McCauley, Fewtrell, and Popper (2003) found that the ears of fish (pink snapper (*Pagrus auratus*)) exposed to an operating airgun (with a sound source level of 203.6 dB re 1 μPa) sustained extensive damage to their auditory hair cells. The airgun was towed from start up at 400 to 800 m (1,312 to 2,624 ft) distance to 5 to 15 m (16 to 49 ft) at closest approach to the fish. Auditory damage was severe, with no evidence of repair or replacement of damaged sensory cells up to 58 days after exposure to airgun emissions. Physical and physiological, hearing impairment, and behavioral effects on fish and fish prey could occur at all water depths of the proposed Lease Sale Area. There could be chronic behavioral and physiological effects to fish at less intense sounds, and acute effects for individuals within a few meters of a sound source that is >180 dB, or at 50 to 90 dB above the hearing threshold of fish species.

Indirect impacts of exposure on the fecundity and survival of fishes may occur. Fishes with impaired hearing may have reduced fitness, potentially making them vulnerable to predators and possibly unable to locate prey, sense their acoustic environment effectively, or in the case of vocal fishes, communicate with other fishes. Some fishes exposed to airgun emissions have been observed to display aberrant and disoriented swimming behavior, suggesting that damage to the ears also may have vestibular impacts (McCauley, Fewtrell, and Popper, 2003).

Marine seismic and geohazard surveys would be conducted during the spring to late fall seasons to allow surveys to take place during the ice-free period. Because of this timing, some fish are of greater concern due to their distribution, abundance, trophic relationships, or vulnerability in relation to noise and seismic emissions. These species include (1) fishes known to be particularly important in the trophic food web, including capelin and Pacific herring (an especially sensitive herring species); and (2) 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.

Migratory species at risk of spawning delays or disruptions include Pacific herring, capelin, Pacific salmon, and Pacific sand lance. Pacific herring are hearing specialists and are some of the most acoustically sensitive species occurring in the proposed Lease Sale Area. They are, therefore, some of the most likely fishes to exhibit displacement and avoidance behaviors due to noise and seismic activities.

Eggs and larvae are more vulnerable to direct and indirect effects from sound than juvenile and adult fish as they are much less mobile, instead typically relying on currents for locomotion. In some instances, eggs are fixed to the substrate and therefore completely stationary. Sound levels in the vicinity of 220 dB have been shown to be lethal to fish eggs and larvae (Davis et al., 1998). These sound levels correspond to a distance of 0.6 to 3 m (2 to 10 ft) from an airgun. Visible damage to larvae can occur at 210 dB, which corresponds to a distance of approximately 5 m (16 ft) from an airgun (Turnpenny and Nedwell, 1994; Davis et al., 1998).

Fish eggs and larvae are unable to escape exposure to airgun noise associated with seismic surveys. However, the potential for impact is very low given that the airguns would need to pass within meters of the eggs or larvae to have any detrimental effect. Although it is likely that some eggs and larvae will be exposed to detrimental sound levels, the small fraction of the proposed Lease Sale Area covered by seismic surveys, and the widespread nature of the resource in Cook Inlet make a population-level impact highly unlikely.

Depending on the relative scattered distribution and hypothetical frequency of post-lease seismic surveys, the effects of seismic surveys to fish populations in the proposed Lease Sale Area and adjacent waters are not expected to be substantial. It is possible that seismic surveys may temporarily displace fish from the area where airguns are in use. Seismic surveys are fleeting operations; hence, any fishes proximately displaced due to potential avoidance are likely to backfill the surveyed area in a matter of minutes to hours. Fishes of any life stage in close proximity to airgun emissions may suffer sublethal injuries that reduce individual fitness, fecundity, or survival. Seismic surveys are not expected to have measurable lethal effects on fish populations in the defined area. Indirect effects would be spatially and temporally limited and should not produce substantial detrimental impacts to regional fish populations. Effects of seismic surveys on fish and shellfish would be minor, due their highly localized and temporary nature.

Noise-related disturbance effects on fish and direct loss or degradation of fish habitats are likely to occur during development activities in the marine environment. Potential pipeline locations would be evaluated on a site-specific basis to avoid or to minimize adverse construction-related impacts to fish habitats. The installation of new pipeline would be anticipated to result in temporary and localized minor adverse impacts to fish and fish habitats.

Drilling and Equipment Noise

Activities associated with exploration, delineation, and production structures produce a wide range of sounds at frequencies and intensities that may be detected by fish and shellfish. Some of these sounds could mask a species' reception of sounds to detect a predator or prey. See the following section for more details on how drilling rig noise could impact fish and shellfish.

The noises generated from exploratory drilling differ from seismic surveys in two key ways: (1) they are less intense, and (2) they are more stationary and persistent. A drilling operation has a single source of sound emanating from a fixed location for up to 90 days at a time. The sound produced by the drilling operation consists of loud mechanical noises emitted over a range of frequencies and intensities. While the intensity of the sound is less than airgun arrays, a potential stationary zone of displacement would be created around the wellsite. If this zone of displacement is located in important spawning, fish-rearing, or feeding habitat, fish could be negatively impacted over time.

In the short term, these sounds may frighten, annoy, or distract a fish or shellfish and lead to physiological and behavioral disturbances. The noises could affect fish and shellfish, causing them to leave a source location or adjacent area. Energetic consequences would depend on whether suitable food is readily available. However, over the long term, this impact could be naturally mitigated by habituation of fish to the noise produced by the drilling activity. Because the noise would be somewhat regular in type and source, it is possible that some fish species may become habituated to them and the zone of displacement may be reduced over time.

Due to the relatively small size of a platform, height above water, and existing underwater noise in Cook Inlet, noises emitted from a platform is negligible contribution to the acoustic environment.

Vessel Noise

Fishes inhabiting or transiting the proposed Lease Sale Area could be subjected to noise from offshore vessel traffic throughout all phases of the Proposed Action. Numerous vessel roundtrips would occur between the onshore facilities and offshore locations, particularly during the exploration and development phases. Vessels cause a path of physical disturbance in the water that could affect the behavior of certain fish species, depending on the type of vessel, life history of the fish species, and water depth. Free-swimming fish in the immediate vicinity may avoid the vessels. Fish species in the coastal and marine environments could be disturbed by the presence and passing of vessels during trips from offshore activities to coastal staging areas.

Vessel activities may disturb pelagic and demersal fish and shellfish, potentially displacing them from preferred habitat, as vibrations and noise from vessels passing by increases. Pressure waves from vessel hulls could displace fish in the surface water habitat and cause injury or mortality to non-swimming and weakly swimming fish life stages and fish prey. Cavitation of bubbles generated by vessel hull structures and vibrations from vessel pumps could result in barotraumatic injury and mortality of epipelagic non-swimming and weakly swimming fish life stages and fish prey (Hawkins and Popper, 2012).

Engines from the vessels may radiate considerable levels of noise underwater. Diesel engines, generators, and propulsion motors contribute considerably to the low-frequency spectrum. Much of the machinery necessary to drive and operate a ship produces vibration within the frequency range of 10 Hz to 1.5 kHz, with the consequence of radiation in the form of pressure waves from the hull (Mitson and Knudsen, 2003). In addition to broadband propeller noise, there is a phenomenon known as “singing,” when a discrete tone is produced by the propeller, usually due to physical excitation of the trailing edges of the blades. This can result in very high tone levels within the frequency range of fish hearing. The overall noise of a vessel may emanate from many machinery sources. Pumps in particular are often considerable producers of noise from vibration and, at higher frequencies, from turbulent flow. Sharp angles and high flow rates in pipework also can cause cavitation, and even small items of machinery might produce quite high levels of noise. Fish may exhibit avoidance behavior when subjected to loud noises from a vessel. Abnormal fish activity may continue for some time as the vessel travels away. However, vessel noise is inherently transient, rendering adverse impacts temporary. Fish in the immediate vicinity of vessels may also exercise avoidance.

Noise-related disturbance effects on fish and shellfish and direct loss or degradation of fish habitats also are likely to occur during development activities in the marine environment. Potential pipeline locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts to fish habitats. Installation of the new pipelines, but also the anchoring and transiting of construction vessels, would be expected to result in temporary and localized adverse impacts to fish and shellfish, and their habitats. The minimum potential length of the support vessel travel routes could vary depending on a pipeline’s given location.

Production platforms would require continual servicing from vessels which, as discussed previously, produce noise when in transit. Vessel activity would be less frequent and generally restricted to an area between the drillsites and shore bases. Any disturbance or displacement by vessels should be localized and short-term (minutes to hours), limited to the time of construction and shortly thereafter. Effects would likely be limited to small numbers of individuals in the immediate vicinity of construction activities. All of these noise impacts, however, would have a negligible effect on fish resources. Vessel noise-related disturbance on fish and shellfish during decommissioning activities would be similar to impacts described previously.

4.3.5.6. Physical Presence, Including Lights

Existing information on fish attracting devices indicates that fish species are attracted to offshore structures (Fabi et al., 2004; Franks, 2000) because of the additional hard substrate habitat they provide for invertebrates, and protective habitat for finfish. During production, OCS platforms stand out from all other artificial reefs because they occupy the entire water column, from the seafloor through the splash zone. All structures and underwater obstructions likely would be removed once the lease is relinquished or terminated and all production stops in the OCS block.

Limiting fishing activities a minimum of 500 m (1,640 ft) from the platform would create a long-term minor impact to finfish species in the area, with beneficial and adverse components. As fishing activities would be prohibited within the exclusion zone, pelagic species utilizing the 500-m (1,640-ft) area would not be subjected to fishing pressures, creating a beneficial impact. Platform placement would introduce a high relief hard substrate that could provide habitat for some prey species, which subsequently could attract managed species throughout the water column (Fujii, 2015). The oil and gas platform components placed on the seafloor and suspended within the water column also would create substrate for the aggregation of species that utilize seafloor structure. Aggregation of shellfish near seafloor structures, however, would increase their risk of predation. Furthermore, a platform's deck, approximately 20 m (65 ft) above the water, casts a shadow during the day that fish use to hide from predators; at night the operational lights create a "halo" of light in the water that attracts fish and predators.

Lights would be used during evening and night hours on platforms and supply vessels. Lighting on board the platforms would be designed to minimize nighttime impacts and would be used to ensure safety and security when operations require lighting. The brightest light would be a rotating, flashing beacon to identify the highest point of the platform (approximately 76 m (250 ft) above sea level). Other lighting would enable nighttime operations to be conducted throughout the platform. Platform lighting for operations would be a fairly low light output; the equivalent of a typical high beam on an automobile. Offshore pipelines would likely be buried, and lighting would not be required unless repair or maintenance were necessary during night hours. In this event, a repair vessel would be present temporarily. Lighting may be used to aid in the repair but likely would not be used for extended periods of time.

Fishes may be attracted by a platform's nighttime light-field or concentrations of prey that may be found in the waters around platforms, including small schooling fish and squid (Shaw et al., 2002). These attract larger predators, rendering each in turn vulnerable to other predators.

Platform removal has the potential to injure or kill fish and alter habitat in the vicinity of decommissioning operations. The associated disturbance and activity is expected to deter the fish from approaching the removal site. Removal of the infrastructure would temporarily increase turbidity in the water column and demersal species would likely leave the area. Some species of fish may return although the artificial reef structure created by the platform would no longer exist.

Effects on fish and shellfish from physical presence and lighting associated with the Proposed Action are considered minor, but would vary depending on the extent of the disturbance. Negative impacts would include loss of benthic habitat, increased nighttime predation in demersal waters, injury, and mortality.

4.3.5.7. Trash and Debris (Including Non-Hazardous Domestic Waste)

During exploration, development, and production, trash and debris from vessels and platforms, whether accidental or intentional, includes domestic waste, garbage, and plastics. Offshore operations generate trash made of paper, plastic, wood, glass, metal, and other materials. Debris floating on the surface, suspended in the water column, covering the benthos, or along the shoreline can have deleterious impacts on pelagic and demersal fish as well as shellfish (Hoagland and Kite-Powell, 1997; Johnson et al., 2008). Direct impacts to pelagic and demersal fish exposed to trash and debris range from superficial exposure to ingestion and related effects (EPA, 2015c). Fish and mobile shellfish can become entangled in marine debris or ingest plastics that they mistake for food. Plastic debris can constrict a fish's movements, or kill the fish through exhaustion or infection from deep wounds caused by tightening material. Fish may starve to death because the ingested plastic clogs their intestines, thus preventing them from obtaining vital nutrients. Toxic substances present in plastics can also contaminate benthic habitat, which can cause death or reproductive failure in fish and shellfish that utilize the contaminated habitat (EPA, 2015c).

All vessels are subject to the regulations of MARPOL 73/78, as modified by the Protocol of 1978 (NOAA, 2010b). MARPOL includes six annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (IMO, 2010). Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO, 2010). Adherence to these regulations minimizes or negates the likelihood of discharges of potentially harmful substances into the marine environment.

Under the Proposed Action, all authorizations for OCS activities would include guidance for trash and debris awareness (see Section 4.2.8). The discharge of trash and debris is prohibited (33 CFR 151.51 through 151.77) unless it is passed through a comminutor and can pass through a 25-mm (1-in.) mesh screen. Discharge of plastic is prohibited regardless of size. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste. Accidental discharge of plastics and all other trash and debris from vessels and platforms is possible but unlikely to occur. If an accidental discharge does occur, it is likely to be a rare event and the potential amount of trash or debris is likely to be small and localized, thus effects would be negligible.

4.3.5.8. Accidental Oil Spills and Gas Release

Accidental events could include small (<1,000 bbl) and large (≥1,000 bbl) spills stemming from fuel transfer accidents, platform fuel tank ruptures, and loss of well control of gas, and from platforms, MODUs, and pipelines. Small spills include the spill of diesel fuel and crude and refined oil while large spills include the spill of crude and refined oil and the release of gas. Accidental discharge of oil can occur during almost any stage of exploration, development, production, or decommissioning on the OCS or in nearshore coastal areas. Small and large oil spills are considered accidental events, and the CWA and Oil Pollution Act include regulatory and liability provisions designed to reduce damage to natural resources from oil spills.

Small Oil Spills (<1,000 bbl)

The estimated numbers of small spills for the Proposed Action are summarized and discussed in Section 4.2.14. Oil spills can occur from many sources, including equipment malfunction, ship collisions, ship refueling, pipeline breaks, human error, or severe storms. Oil spills also can be attributed to support activities associated with product recovery and transportation. In addition to crude oil spills, chemical, diesel, gas, and other contaminant spills can occur with OCS activities (Hanson, Helvey, and Strach, 2003; NPFMC, 2015). Diesel or refined oil spills can occur during the exploration phase. An estimated 10 small spills with a volume up to about 80 bbl of diesel or refined oil could occur during the 6-year exploration period. Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within the first 24 hours, although a small proportion of the heavier fuel components could adhere to PM in the upper portion of the water column and sink. Small spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products.

The disturbances and associated adverse impacts on fish and shellfish from accidental spills can be reduced through the operating procedures required by regulatory agencies. Potential spill impacts would be reduced by incorporation of a spill prevention, control, and countermeasure (SPCC) plan into the vessel and platform operations. This would include specialized training for the personnel plus mechanical safeguards such as quick-closing valves in case of unexpected disconnections. Such risks would be further reduced by avoiding fuel-related operations in adverse weather.

In whatever quantities, accidental oil spills can affect fish and shellfish, and their habitats. Most spills are expected to be small, although multiple chronic spills could occur. Many factors determine the degree of damage from a spill on fish and shellfish, including the type of oil, size and duration of the spill, geographic location of the spill, and season. Small spills tend to degrade quickly in the marine environment, but spills <1,000 bbl could have some localized adverse effects to fish and shellfish. Adverse effects to fish and shellfish can be compounded if small spills occur frequently within close proximity or are on the larger side of the scale towards 1,000 bbl. Toxic effects on fish and shellfish (particularly early life stages) could occur in the immediate area of a spill. Even at low concentrations that are not directly lethal, some contaminants in oil can cause sublethal effects on sensory systems, growth, and behavior of fish and shellfish, or may be bioaccumulated (NOAA, 2010a).

Although oil is toxic to fish and shellfish at high concentrations, certain species are more sensitive than others. Pelagic and demersal fish adults, juveniles, eggs, and larvae would be exposed, and there could be acute effects on these various life stages for the fish species in the area. In general, the early life stages of fish and shellfish (eggs and larvae) are most sensitive, juveniles are less sensitive, and adults least so (Rice et al., 2000). However, at low concentrations that are estimated to occur in the proposed Lease Sale Area, the spill effects on each life stage would be short-term and spatially limited.

Accidental spills into the water column could cause a direct adverse impact on water quality (see Section 4.3.2.5) as well as direct and indirect adverse impacts on pelagic fish and shellfish larvae. Strong-swimming demersal fish such as sablefish, walleye pollock, Atka mackerel, and Pacific hake that are exposed to oil spills in the upper water column may be capable of swimming away from oil slicks. Eggs, larvae, and juvenile stages of fish in the water column would have continued exposure to oil due to their inability or limited ability for motility. Motile shellfish such as shrimp and crabs could be susceptible to acute and chronic impacts from spilled oil, resulting in lethal and sublethal effects.

Isolated small accidental spills are not expected to affect the overall water quality of Cook Inlet. However, oil is toxic to egg and larval life stages at low concentrations. Small spills may adversely affect individual fish and shellfish prey organisms. It is likely that individuals (e.g., prey organisms, eggs, larvae) encountering oil, even at low concentrations, could suffer deformities or mortality. These effects on the food chain could have indirect effects on larger predatory fish and shellfish by reducing the available prey base and foraging opportunities for predators.

The Cook Inlet region is a migratory corridor and early life rearing area for all five species of Pacific salmon. These anadromous fish transit much of the area, as smolts leaving natal (home) freshwater drainages and as returning migrant adult spawners. The migratory behavior of these anadromous fish could be affected adversely by an oil spill as well as the nearshore foraging of out-migrating smolts. Pacific herring, Pacific sand lance, and walleye pollock are the most important forage fish in Cook Inlet, and their extensive utilization of nearshore habitats may increase their exposure to accidental oil spill effects in the nearshore environment. Other forage fish that could be impacted by oil spills include capelin, eulachon, and rainbow smelt, which inhabit neritic waters of the continental shelf (NPFMC, 2014). Effects of oil spills in nearshore intertidal areas could persist for generations and might have multiple effects by affecting more than one life stage. The overall effects of individual small spills on fish and shellfish would be localized because of the small area of Cook Inlet waters that would be affected.

Chronic small oil spills could have an adverse effect on fish and shellfish because residual oil can build up in sediments and affect living marine resources. Low levels of PAHs from chronic pollution can accumulate in salmon tissues and cause lethal and sublethal effects, particularly at the embryo stage. Effects on fish from low-level chronic exposure may increase embryo mortality, reduce marine growth (Heintz et al., 2000), or increase straying away from natal streams by returning adults (Wertheimer et al., 2000). Previous studies in Cook Inlet and Shelikof Strait have not indicated a buildup of hydrocarbons from production in state waters within lower Cook Inlet (Boehm, Cook, and Murray, 2011).

For isolated small spills, minor impacts are expected to pelagic and demersal fish and shellfish. Population-level effects would not be detectable for small accidental spills. Mitigation measures such as SPCCs would be implemented to reduce the occurrence and volume of accidental spills. Widespread annual or chronic disturbances or habitat effects are not anticipated to accumulate across one year, and localized effects are not anticipated to persist for more than one year.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large oil spill can occur from many possible sources, including equipment malfunction, ship collisions, pipeline breaks, human error, or severe storms. Oil spills can also be attributed to support activities associated with product recovery and transportation. Crude oil and condensate spills may occur directly from platforms, MODUs, or ruptured pipelines during development and production. Large oil spills could affect marine, estuarine, and tidal riverine fish and shellfish species depending on the location, volume, and trajectory of the spill and the time of year it occurs. Large spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within the first 24 hours, although a small proportion of the heavier fuel components could adhere to PM in the upper portion of the water column and sink. Large spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products.

A large spill of crude oil resulting from rupture of one of the undersea production pipelines in the area also would be a very remote possibility. Spilled materials would rapidly dilute under Cook Inlet conditions with strong lateral and vertical mixing. Local spill trajectory would depend on tide stage as well as wind and wave direction. However, the residence time would be relatively short; net flow is expected to be southwestward from the site, out of Cook Inlet. In the unlikely event that a large oil spill occurred, the spill and the response would affect fish and shellfish populations. Cook Inlet is unlike most OCS areas in that it is an estuary with surrounding shoreline. Even though large spills are unlikely, if they occur, the likelihood of contact with part of the shoreline is relatively high. Research on effects of oil spills have stated that the likely effects of a large oil spill would include the mortality of adult forage fishes as well as lethal and sublethal effects to millions of eggs and the juvenile stages of finfishes and shellfishes.

Large oil spills would be expected to persist on the water long enough (30 days) for a trajectory analysis to predict the fate and distribution of oil. Much of the spilled oil would disperse and weather naturally under Cook Inlet conditions. Residence time in the water column would be relatively short, and net flow is expected to be southwestward out of Cook Inlet. Risk of spill impacts would be reduced by incorporation of an SPCC plan, including specialized training for personnel and mechanical safeguards such as quick-closing valves in case of unexpected disconnections. Such risks would be further reduced by avoiding fuel-offloading operations in adverse weather.

Lease sale-specific oil spill effects on fish resources also considered the conditional and combined probabilities generated from the OSRA model. A large oil spill in the proposed Lease Sale Area would adversely affect fish and shellfish resources, and associated habitat by causing lethal and sublethal effects. Intertidal beach and bay habitats in Cook Inlet are most likely to suffer long-term impacts if a large oil spill were to occur (USDOI, MMS, 2003). Oiled intertidal areas could lead to considerable mortality of eggs and juvenile stages in the affected areas. Elevated levels of developmental malformations and physiological aberrations in eggs and juvenile stages can cause reduced survival to adulthood, thereby delaying recovery of subpopulations affected by an oil spill. Organisms that rely most heavily on these environments would be most affected. In intertidal areas, some of the species and life stages that might be most affected are Pacific herring eggs, Pacific sand lance, and capelin eggs and adults, yellowfin sole, pink salmon eggs, adult squid, juvenile sablefish, walleye pollock larvae and adults, Pacific cod larvae and adults, eulachon juveniles, and Greenland turbot eggs (USDOI, MMS, 2003). A large spill would primarily affect beach and intertidal habitat because it would persist in those areas, possibly for more than a decade.

Effects on marine and estuarine habitat would be less because of limited effects on these areas and rapid recovery (months to a few years). Depending on the timing of the spill, adult fish on spawning runs, such as Pacific salmon, could be the most impacted, although any marine or estuarine fish species present in the spill region could be affected. Pacific salmon runs occur from late spring to early fall. Pink salmon have a unique odd/even year spawning strategy. A large oil spill during a spawning run could interrupt some spawners, or even substantially reduce a cohort from a particular river or stream. Although recovery of specific cohorts or spawning streams could take years, it is not expected that the effects to fish and shellfish resources as a result of a large oil spill would cause population-level changes in the central Gulf of Alaska. Depending on the location of the spill, adverse effects on fish and shellfish resources from oil spills would possibly be of long duration, but likely be less than severe in magnitude because of the length of the salmonid spawning season and the variability in spawning age for most species of Pacific salmon. Consequently, the overall effects of a large spill would result in moderate impacts on fish and shellfish resources. Although unlikely, BOEM estimates that a well control incident of a single well could occur and result in the release of 8 MMcf of natural gas in one day. A large gas release and ensuing explosion and fire could result in lethal and sublethal effects to fish and shellfish in the immediate vicinity of the blowout. Natural gas condensates that did not burn would disperse very rapidly at the blowout site; thus, it is unlikely that gas would affect fish or their food sources. Fish mortality associated with a blowout could range from a few to hundreds of individuals. However, such an event would have minor impacts, as loss would likely involve several species of fish, with no expected population-level effects.

Oil-spill Risk Analysis

The OSRA model defines LSs for anadromous fish in Appendix A, Table A.1-12. Because fish and fish larvae are ubiquitous throughout the open water habitat, specific concentration areas were not defined as ERAs. For the purpose of this analysis, OSRA results for whale (Table 4.3.2-15), seal, and sea lion ERAs (Table 4.3.2-16) are used to consider temporal and spatial contact within the OSRA study area.

A large spill has the highest percent chance of contacting ERAs on the western and southern sides of Cook Inlet, including Augustine, South Cook, and Clam Gulch (ERAs 11 to 14 and 17) for harbor seals, and West Cook Inlet beluga critical habitat (ERA 72) and western Lower Cook Inlet (ERA 104) for whales.

In addition to the summary data provided in Tables 4.3.2-15 and 4.3.2-16 for the highest percent chance of contact from all LAs and PLs, details in Appendix A, Table A.2-4, provide insight into areas with a high percent chance of contact based on a large spill occurring in a particular LA or PL. For example, a large spill originating in PL3 has an estimated 97% chance of contacting South Cook HS 1b, upper Kamishak Bay (ERA 13) within 30 days; a large spill originating from PL4 has an estimated 97% chance of contacting Outer Kachemak Bay (ERA 145) within 30 days.

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. The relatively low percent chance of one or more large spills occurring and contacting various environmental resources is illustrated by examination of the highest combined probabilities. As shown in Appendix A, Table A.2-61, for many

ERAs, the highest combined probabilities within 30 days range from 11% to 14% for the west side of Cook Inlet. The combined probability of one or more large spills occurring and contacting Outer Kachemak Bay (ERA 145) is 10% within 30 days over the life of the Proposed Action. All other areas had combined probabilities <10%.

Fish species from these resource areas potentially affected by oil spills are adult anadromous fishes and eulachon transiting lower Cook Inlet; out-migrating juvenile salmon entering western Cook Inlet from natal rivers and streams; herring, Pacific cod, and halibut; and walleye pollock in offshore waters in western and southern Cook Inlet. Additionally, fish and shellfish pelagic eggs and juvenile stages inhabiting near-surface waters may experience lethal and sublethal effects.

Anadromous fish in Cook Inlet and the surrounding region are represented in the OSRA model by LSs and GLSs listed in Table A.1-12 of Appendix A. A summary of the highest percent chance that a large oil spill from any LA or PL will contact these anadromous fish resources within 3 and 30 days during summer and winter is provided in Table 4.3.2-7.

Table 4.3.2-7. Highest Percent Chance of a Large Spill Contacting Anadromous Fish LSs[1]

OSRA Feature Type	Highest Chance of Contact	Summer		Winter	
		3 days	30 days[2]	3 days	30 days[2]
Land Segment (LS)	≥0.5–<6	25, 28, 34, 37, 38, 40, 54, 55, 56, 57, 58, 60, 61, 62	18, 19, 20, 21, 22, 23, 24, 25, 26, 34, 37, 38, 40, 54, 55, 57, 58, 60, 63, 81, 82, 83, 84, 85, 86, 87	25, 26, 28, 37, 38, 40, 54, 55, 56, 57, 61, 62, 63	21, 22, 23, 24, 25, 26, 27, 37, 38, 39, 40, 54, 55, 56, 57, 58, 60, 61, 63, 81, 82, 83, 84, 85, 86, 87, 88
	≥6–<25	30, 31, 32, 33, 35, 36	28, 30, 31, 32, 33, 35, 36, 56, 61, 62	30, 31, 32, 33, 34, 35, 36	28, 30, 31, 32, 33, 34, 35, 36, 62

Notes: [1]Highest percent chance from any launch area (LA) or pipeline (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5 are shown.
[2]Note that the highest percent chance of contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.
Source: Appendix A (Tables A.1-12, A.2-27, A.2-29, A.2-32, A.2-34, A.2-47, A.2-49, A.2-52, and A.2-54). Maps of LSs are provided in Appendix A, Maps A-3a through A-3d.

LSs with the highest percent chance of contact from a large oil spill in either season from any PL or LA include northern Kamishak Bay, Chinitna Bay, Tuxedni Bay, and Chisik Island (LS 30 to 36) on the western side of Cook Inlet and Seldovia and Port Graham (LS 61 and 62) on the eastern side. The highest combined probabilities within 30 days range from 1% to 3% for the west side of Cook Inlet (LS 30 to 36) to <0.5% to 1% for the east side of Cook Inlet (LS 61 to 62). The LSs along the western shore of the Kenai Peninsula and the southwestern shore of Cook Inlet contain numerous rivers and streams that are particularly important to anadromous fish between May and November (Appendix A, Table A.1-12). Oil contact in shoreline and nearshore environments could alter the migratory behavior of returning adult salmon as well as impact forage fish such as herring and sand lance. Fish may be deterred from entering to spawn or leaving after maturation if coastal rivers and streams are oiled. Anadromous species that spawn near river mouths could experience chronic or acute effects, particularly on early life stages. Based on the areas estimated to be contacted by spilled oil, fish species most likely affected include intertidal, estuarine, and 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.

Weathervane scallop beds located off Augustine Island in 38 to 115 m (120 to 360 ft) of water likely would go undamaged in the event of a large oil spill in the proposed Lease Sale Area because their depth would likely protect them from direct contact with surface oil. However, the scallop beds may become commercially unacceptable for market due to actual or perceived contamination and tainting. Actual contamination is possible; however, the likelihood is regarded as low, in part due to the large water exchanges that occur as part of the dynamic hydrography of Cook Inlet. Oil contacting the beaches could affect shellfish, particularly razor clams along the west side of Cook Inlet and in small bays off of

Kachemak Bay. In any area contacted by oil, populations of the intertidal organisms could be depressed measurably for about a year, and small amounts of oil likely would persist in the shoreline sediments for more than a decade, which could pose a moderate localized impact.

Fish, shellfish, and their habitats are expected to be exposed to short-term medium-intensity impacts, with localized areas such as western Cook Inlet potentially having expanded impacts on fish and shellfish resources. Mortalities or disturbances could occur, although not likely on a scale that would result in population-level effects. Overall impacts of a large spill would be moderate. Widespread annual or chronic disturbances or habitat effects could persist for more than a year and up to a decade. Overall effects from a large oil spill on Cook Inlet fish and shellfish resources could be widespread or long lasting, and mortality of individuals would occur.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. If clean-up operations include sections of the beach, or intertidal zones, access to spawning habitat for some species may be restricted.

Pelagic fishes may be affected by mechanical recovery of spilled material, but are expected to avoid an oiled area and to move away from vessels and booms or skimmers. If spill response activities are occurring during spawning runs, some fish could experience difficulty reaching their spawning grounds. However, these avoidance impacts would be short-term and localized to the spill area. Benthic fishes and shellfish would not likely be affected by mechanical recovery activities occurring at the surface. The effects of mechanical recovery on fish resources would be negligible.

In-situ burning of spilled oil is used to remove oil from the surface and would impact fish and shellfish in the immediate area due to increased water temperature and residue from the burn sinking to the bottom. Death of pelagic fishes that did not move away from the spill is possible in the immediate burn area. As with lower trophic organisms, residue from a burn can sink and smother benthic fish and shellfish. These effects are expected to be short-term and localized to the immediate burn area, and would be considered minor.

The use of dispersants could result in impacts on plankton communities. Ramachandran et al. (2004) suggested that the use of oil dispersants will increase the exposure of fish eggs and larvae to hydrocarbons in crude oil. This has particular importance if dispersants are used while outmigrating salmon are present in the area. Results in a study by Ortman et al. (2012) suggested that the addition of dispersant and dispersed oil to northern Gulf of Mexico waters in 2010 may have reduced the flow of carbon to higher trophic levels, leading to a decrease in the production of zooplankton and fish on the Alabama shelf. Dispersed oil would also have toxic effects to benthic fish communities, as described previously for oil spill impacts.

Spill impacts and cleanup operations will be influenced by time of year in Cook Inlet. An oil spill occurring into ice may persist for a longer period of time than during ice-free conditions (Buist et al., 2008; Payne, McNabb, and Clayton, 1991). Under calm conditions and cold temperatures in restricted waters, vertical mixing and dissolution would be reduced (Buist et al., 2008). A large spill occurring on or under ice would be trapped and persist until the ice melted, allowing the spill to disperse (Drozdowski et al., 2011), and trapped oil can be transported by currents to areas more distant from the site of the accidental spill. Volatile components of the spill would be more likely to freeze into the ice rather than evaporate. Response efforts would be hindered and aided by the presence of ice. Ice will contain a spill (reduce spreading), concentrate it, and act as a barrier to shoreline oiling. However, ice also will make a spill difficult to detect, locate, and access. Natural processes would aid the degradation of the oil and gas released during a large spill, but at a slower rate than in warmer waters.

These effects could be long-lasting and widespread for fish and shellfish if a large spill occurs, while a small spill would be more localized. Effects are unlikely to be population-level, though, as fish can avoid areas of spilled oil, and benthic community impact on shellfish would be limited spatially by the settling of oil and dispersant. Depending on the size of the spill and the time of year, use of dispersants could have minor (small spill) to moderate (large spill) effects on fish and shellfish.

Increased vessel traffic would add noise to the environment, and would increase the chance of small discharges from response vessels. Effects to fish and shellfish would be extremely short-term and would have negligible impact overall.

4.3.5.9. Impact Conclusions

The effects of routine exploration, development, and production activities on the fish and shellfish would have a minor localized impact on fish and shellfish in the short term, and potentially attract fish and shellfish to artificial structures in the long term. During the exploration and development phases, individuals would likely be displaced from a local area or risk injury or death if in the direct location of the activities. Once in production, artificial reef structures created by the platforms and associated infrastructure would attract fish and shellfish. The effects of routine exploration, development, and production activities would impact individual fish and shellfish locally, but not at a widespread population level. Consequently, the overall effects of routine exploration, development, and production activities on fish and shellfish would be **minor**.

The effects of small spills would likely be localized and temporary, resulting in **minor** effects to individual fish and shellfish. Although, a small oil spill could cause minor effects to fish and shellfish, it is unlikely to have a measureable effect on local populations.

A large oil spill during the summer or fall seasons may result in the greatest impact to pelagic finfish because this is when many pelagic migratory finfish are most abundant and have eggs and juvenile stages in the central Gulf of Alaska. Eggs and fry of some bentho-pelagic and demersal fishes may suffer lethal and sublethal effects from oil contact. These fish species' life stages would be more easily affected because of their sensitivity and their inability to avoid oil. A large oil spill may cause local pelagic fish stocks or subpopulations to decline in abundance, requiring multiple generations for the impacted stock or subpopulation to recover to its former status. Although a single large spill may cause declines in subpopulations of multiple species inhabiting the proposed Lease Sale Area, they are not expected to cause a measurable decline in abundance requiring three or more generations for the indicated population of the central Gulf of Alaska to recover to its former status.

A large spill impacting subtidal and intertidal habitats would have a **moderate** impact on fish and shellfish, resulting in lethal and sublethal effects on forage fish and intertidal species. Local populations of nearshore fish and shellfish would be measurably depressed for about a year, and small amounts of oil could persist in shoreline sediments for a decade or more. However, the spill would affect a small portion of the total habitat and likely would be limited to subpopulation-level effects.

Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for fish and shellfish for routine activities or accidental spills. Also, GIUE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment would not alter impact conclusions for fish and shellfish for routine activities.

4.3.6. Marine Mammals

This section identifies IPFs resulting from activities associated with the Proposed Action, and discusses the manner in which each IPF may affect various species of marine mammals. Some marine mammal species are extralimital to the proposed Lease Sale Area but may occur within the larger geographic area considered in the OSRA study area (NOAA 2015b; Appendix A, Map A-1). For those species, the only IPF that could foreseeably affect them would be a large oil spill. Consequently only oil spill impacts will be analyzed for species that do not occur in the proposed Lease Sale Area. In some instances there may be a paucity of species-specific information relating to the effects of an IPF on a specific species. In these cases it is an accepted practice to use existing data for similar species as a proxy if that information is accurate, available, relevant, and otherwise supports the analytical process.

IPFs for marine mammals include the following:

- Seafloor disturbance and habitat alteration
- Drilling discharge
- Active acoustic sound sources
- Drilling and equipment noise
- Vessel noise
- Physical presence, including lights
- Trash and debris (including non-hazardous domestic waste)
- Vessel traffic
- Aircraft traffic and noise
- Accidental oil spills and gas release

The activities of the Proposed Action could result in direct and indirect effects to marine mammals and their habitats. Direct effects are those that are immediate in space or time in proximity to their cause. Indirect effects are those separated in space or time from their cause. An example of a direct effect would be mortality resulting from a collision with a vessel. An example of an indirect effect would be the abandonment of a habitat area by a species due to the degradation of that habitat (e.g., loss of prey, contamination, increasing anthropogenic presence over time). The magnitude of impacts from the Proposed Action depend on the specific species' sensitivity to the disturbance as well as the location and season in which the disturbance occurs (e.g., during whale migrations or near seal rookeries). The life history, distribution, and abundance of marine mammals that occur in the proposed Lease Sale Area are discussed in detail in Section 3.2.3.

The discussion of potential effects of seafloor disturbance and habitat alteration applies to marine mammals generally, and is supplemented with species-specific consideration where such effects are known and reported in published literature. The Proposed Action does not entail leasing of designated critical habitat areas for the beluga whale and the southwest DPS of the Northern sea otter.

4.3.6.1. Seafloor Disturbance and Habitat Alteration

Sources of seafloor disturbance and habitat alteration in the Proposed Action would likely occur from drilling, anchor placement, nodes, cables, sensors, pipelines, and other equipment on or in the seafloor for the completion of various activities described in the E&D Scenario. Section 2.4 identifies and discusses in detail the seafloor disturbance and habitat alteration expected to occur as a result of the Proposed Action.

Seafloor disturbance, turbidity, and discharge from routine activities may impact marine mammal benthic prey species and potentially the fitness of marine mammals. The extent of habitat alteration to the surface of the seafloor is a product of the volume and physical nature of materials (e.g., mud, sand, cobblestone) that are displaced by the activities described in Section 2.4 (NMFS, 2015d). Seafloor disturbance and scour also occurs from bottom-founded anchors associated with exploratory drilling operations (USDOI, BOEM, 2015d). The seafloor may be physically disturbed from the sedimentation of discharges, potentially resulting in destruction of the organisms living there (Lissner et al., 1991).

The deposition of suspended material downstream of disturbance sites would cause the temporary loss of local benthic communities by smothering from deposition of sediment. Recovery time for substrate disturbances ranges from a few days or months to decades depending on the type and frequency of the disturbance as well as the type of organisms inhabiting the substrate (Lissner et al., 1991). The disturbance of these surfaces and their effects are further defined by the density of particles and the residence time of the water column as well as the area and depth of coverage of the benthic surface by displaced materials (NMFS, 2015d). Effects may include the temporary disruption of pelagic habitat from turbidity caused by suspended material (NMFS, 2015d; Sections 4.3.5.1 and 4.3.5.2).

Turbidity may affect the distribution and diversity of prey species as well as the ability of marine mammals to locate prey in the immediate area of the drilling activity (USDOI, BOEM, 2015e). However, the discharge of drilling fluids and cuttings during drilling activities is unlikely to have large-scale effects on marine mammals, either directly through contact with marine mammals or indirectly by affecting their prey, because the effects would be restricted primarily to the areas immediately surrounding the drillsite and the areas of supporting anchors and chains. Seafloor disturbance will occur in an area where the legs of the drill rig are set down and where the actual well is drilled. The presence of the drill rig is not expected to result in direct loss of marine mammal habitat, but it could result in a minimal loss of marine mammal foraging area(s). Habitat alteration due to pipeline laying and platform construction would be highly localized and likely will not cause major impacts to mobile species. The potential benthic habitat affected would be minor relative to the total benthic habitat in the proposed Lease Sale Area (Section 4.2.1).

Potential lessees will likely use marine seismic survey data to determine the optimal location for drilling. During an OBN survey, nodes containing a geophone and data storage are placed on the sea floor. Greater detail on how seismic survey data are collected is discussed in Section 2.4. Potential effects from seafloor disturbance as a result of seismic surveys during the exploration phase of the Proposed Action will not likely affect marine mammals (see Table 4.2-2).

Section 4.2.1 outlines the potential area of seafloor that could be disturbed as part of the Proposed Action. Although the placement of OBNs may temporarily affect the seafloor habitat, effects are likely to be temporary and small in scale relative to the total benthic habitat in Cook Inlet; therefore, these activities will likely have minimal impact on marine mammal foraging.

BOEM anticipates that geotechnical surveys involving coring could impact a small portion of the seafloor. Several hundred cores may be collected under the Proposed Action; however, sampling in soft bottom areas will produce only minor and highly localized turbidity, which is expected to immediately dissipate when sampling ends (NMFS, 2015d).

It is likely that a jack-up rig or an anchored drillship will be employed for exploration and development drilling. Jack-up rigs and anchored drillships disturb the seafloor due to the placement and removal of stabilizers (i.e., the drilling rig legs on a jack-up rig or the placement of anchors from a drillship). The area of disturbance would vary based on the type of drill rig used and ocean currents, but in most cases includes the area of disturbance from the mudline cellar, the anchoring system for the MODU (i.e., legs of the jack-up rig or footprint of the drillship anchors), displacement of sediments, and discharge of drilling waste (USDOI, BOEM, 2015d).

Based on the E&D Scenario, subsea pipelines are expected to be constructed to transport produced oil and gas from offshore platforms to the nearest landfall location. Section 4.2.1 provides details regarding potential pipeline infrastructure expected to result from the E&D Scenario. Although the placement of subsea pipelines may temporarily affect seafloor habitat, effects are likely temporary and localized, and therefore have minimal impact on marine mammal foraging activities.

Highly localized minor impacts from seafloor disturbance from the Proposed Action on benthic populations would be expected due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations (see Section 4.3.4.1).

Only localized turbidity is expected to occur as a result of the proposed seafloor-sampling activities during the exploration phase (NMFS, 2015d). The turbidity is expected to dissipate after sampling activities have ceased. Seafloor disturbance from anchor handling activities is anticipated to fill in over time through natural movement of sediment. Disturbance associated with mudline cellar excavation or exploration/delineation wells is anticipated to temporarily impact a small area of habitat, which will be rapidly recolonized by benthic organisms (NMFS, 2015d). After oil and gas resources are depleted, operators would shut down the facilities. All wells will be plugged and abandoned, processing modules will be removed, subsea pipelines will be decommissioned, platforms will be disassembled and removed, and the seafloor will be restored. The activities discussed earlier could temporarily disturb the seafloor, and thus foraging areas until the site is restored. No impacts to winter sea ice habitat that is used by sea otters and seals as haul-out platforms are expected.

Overall, seafloor disturbance and habitat alteration could have a few highly localized, short-term effects to a few marine mammals. Potential effects from seafloor disturbance are likely to limit the foraging quality of the disturbed area during drilling, and possibly for a few years afterward in some locations. These effects should be consistent and less than what has been occurring throughout Cook Inlet since the first production platform was created in the 1960s. Seafloor disturbance would occur during the four phases of development; however, there should be no lingering effect on the area once the vessel or drilling rig has left.

4.3.6.2. Drilling Discharges

Discharging drill cuttings or other liquid waste streams generated by the drilling vessel could affect marine mammal habitat and prey. A detailed discussion of drilling fluids and other discharges associated with exploration drilling, of probable scenarios regarding the disposal of these substances, and of the potential effects on water quality from their discharge can be found in Section 4.2.2. Despite a considerable amount of research concerning exposures of marine mammals to organochlorines or other toxins, there have been no marine mammal deaths in the wild that can be conclusively linked to the direct exposure to such substances (O'Shea, 1999).

Any adverse effects on marine mammals from discharges are directly related to whether any potentially harmful substances are released, if they are released to the marine environment, what their fate in that environment likely is (i.e., rapid dilution or biomagnification through the food chain), and whether they are bioavailable to the species of interest (USDOI, MMS, 2003). Additionally, drilling discharge is only expected during the initial stage of drilling and ceases when the marine riser is put in place.

Discharging drill cuttings or other liquid waste streams generated by a drilling rig or vessel could affect marine mammal habitat and displace marine mammals from a drilling location (NMFS, 2014). However, it is likely that marine mammals will avoid the area due to sound energy generated by the drilling activities.

The main impacts from drilling discharges would be temporary turbidity in the water column and localized alteration of the benthic environment around individual wellsites. The settling of drilling fluid and cutting discharge would result in physical disturbance of habitats through the smothering of benthic areas/species as well as the disturbance of pelagic species (Tetra Tech, Inc., 2012). Because the food supply for marine mammals consists of benthic and pelagic species, this could have a localized impact on their food supply (Tetra Tech, Inc., 2012). Impacts to marine mammal food sources from the discharge of drilling fluid and cuttings likely would be limited to a localized area and would not be substantial at a landscape level (Tetra Tech, Inc., 2012)(Section 4.2.1).

The same potential affects to marine mammals discussed earlier in the exploration and delineation drilling during the exploration phase will likely be similar to those is the development phase. Drilling fluids from production wells are expected to be reused, injected to disposal wells, or barged to onshore disposal sites.

Based on the per-species conclusions presented in this section, the discharge of drilling fluids and cuttings generated during exploration and development is not expected to have direct impacts on marine mammal species. However, it should be noted that while potential indirect effects such as bioaccumulation of contaminants may result from the Proposed Action, the intense flushing activity in Cook Inlet may help to mitigate these effects by rapidly diluting discharged materials (USDOI, MMS, 2003). The amount of habitat affected in the proposed Lease Sale Area would be small compared to that available to marine mammal species for foraging. Thus, any potential effects should be localized and minor, affecting a small numbers of individuals with no population-level effects.

4.3.6.3. Noise

Impacts on marine mammals from noises produced as a result of the Proposed Action will depend on the sound sources introduced, the temporal and spatial characteristics of those sources, and the extent of development. Acoustic habitat will be affected by high-intensity short-term noise as well as a "chronic" noise increase over the long-term life of developed lease blocks. There often are multiple phases of development occurring at the same time with certain activities dominating discrete time periods over the life of the field. Seismic and drilling sources are typified as being high intensity but short-term. Marine seismic and geohazard surveys along with drilling will predominate in the exploration phase. Conversely, vessel activity and production noise are long-term low-frequency sources. Vessel noise can be expected in all phases of the scenario. A summary of noise sources for each phase can be found in Section 4.2.5.

Primary noise sources most likely to affect acoustic habitat quality are outlined in Table 4.2.5-1. Detailed descriptions of each noise-related IPF are discussed later in this chapter, and the SPLs for selected sources and operational activities are presented in Table 4.2.5-1.

A wide body of research indicates that marine mammals can be adversely affected from anthropogenic sound in air and in water (see Southall et al., 2007; NOAA, 2015c). Anthropogenic sound can affect marine mammals in several ways, including:

- Behavior disruption
- Sound masking
- Hearing loss
- Physiological stress or injury (including death)

Anticipated impacts from sounds resulting from the Proposed Action include those from seismic surveys, well drilling, installation of platforms and pipelines, and transportation activities (e.g., helicopter and vessel traffic). BOEM has outlined estimated levels of activities in the description of the E&D Scenario. 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 permanent partial to total deafness within a frequency range (Finneran, 2015; Southall et al., 2007).
- A temporary threshold shift (TTS) is defined as a temporary loss of hearing sensitivity wherein no hair cell damage has occurred. Because hair cell damage does not occur in a TTS, hearing losses are temporary with recovery periods that can last minutes to weeks. However, Kujawa and Liberman (2009) reported noise-induced degeneration of the cochlear nerve that was a delayed result of TTS-producing acoustic exposures. The 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 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.
- A compound threshold shift (CTS) occurs when some loss in hearing sensitivity is permanent and some is temporary (e.g., 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 SELs, which measure the accumulation of

energy from every ping/pulse within four frequency bands (Ciminello et al., 2012), or SPLs (NMFS, 2013b):

- Low-frequency
- Mid-frequency
- High-frequency; and
- Very high-frequency

The USFWS and NMFS categorize harassment impacts from sound as Level A or Level B. Under the MMPA, a Level A harassment has the potential to physically injure a marine mammal or marine mammal stock in the wild, and a Level B harassment has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering (16 U.S.C. § 1362(13)).

NOAA (2015c) is in the processes of developing comprehensive guidance on sound characteristics likely to cause injury and behavioral disruption in the context of the MMPA, ESA, and other statutes; however, this guidance is in draft format at the time this Draft EIS was being prepared for publication. Until formal guidance is issued, NMFS will continue to use conservative thresholds of received SPLs from broadband sounds that may cause behavioral disturbance and injury. NMFS established in-water SPL_{rms} thresholds for Level B acoustic harassment to be 160 dB re 1 µPa @ 1 m for impulsive sounds, and 120 dB re 1 µPa @ 1 m for continuous noise. Likewise, the SPL_{rms} threshold for Level A harassment, which could cause injury, has been set at 180 dB re 1 µPa @ 1 m for cetaceans and 190 dB re 1 µPa @ 1 m for pinnipeds (Tables 4.3.2-8 and 4.3.2-9). Sea otters are managed by the USFWS under the ESA and MMPA. Broad sea otter SPL_{rms} thresholds for harassment determination have not yet been set. However, in a recent incidental take permit, the USFWS (2014j) used 160 dB re 1 µPa @ 1 m threshold for Level B harassment, and 190 dB re 1 µPa @ 1 m for Level A harassment. These conservative thresholds are applied to evaluate the potential for sound effects in MMPA incidental take authorizations and, where applicable, ESA Section 7 consultations.

Table 4.3.2-8. NMFS Current In-Water Acoustic Thresholds (Excluding Tactical Sonar and Explosives)

Criterion	Criterion Definition	Threshold*
Level A	PTS (injury) conservatively based on TTS	190 dB for pinnipeds 180 dB for cetaceans
Level B	Behavioral disruption for impulsive noise (e.g., impact pile driving)	160 dB
Level B	Behavioral disruption for non-pulse noise (e.g., vibratory pile driving, drilling)	120** dB

Notes: *All dB re 1 µPa and are based off SPL_{rms}.
**The 120-dB threshold may be slightly adjusted if background noise levels are at or above this level.
Thresholds pertain to received levels (by the marine mammal), not source levels (NOAA, 2014a).

Table 4.3.2-9. NMFS Current In-Air Acoustic Thresholds

Criterion	Criterion Definition	Threshold*
Level A	PTS (injury) conservatively based on TTS	None established
Level B	Behavioral disruption for harbor seals	90 dB
Level B	Behavioral disruption for non-harbor seal pinnipeds	100 dB

Note: *All dB re 20 µPa and are based off SPL_{rms}.
Source: NOAA, 2014a.

The current state of scientific knowledge regarding mammalian hearing and noise impacts supports three distinct sound types as relevant for marine mammal noise exposure criteria: (1) single pulse, (2) multiple pulses, and (3) non-pulses (Southall et al., 2007). Examples of sound sources belonging in each of these categories (based on characteristics of the sound emitted at the source) are given in Table 4.3.2-10.

Table 4.3.2-10. Sound Types, Acoustic Characteristics, Examples of Anthropogenic Sounds.

Sound Type	Acoustic Characteristic	Examples
Single pulse	Single acoustic event; >3 dB difference between received level using impulse versus equivalent continuous time constant	Single explosion; sonic boom; single airgun, water gun, pile strike, or sparker pulse; single ping of certain sonars, echosounders, and pingers
Multiple pulses	Multiple discrete acoustic events within 24 hours; >3 dB difference between received level using impulse vs equivalent continuous time constant	Serial explosions; sequential airgun, water gun, pile strikes, or sparker pulses; certain active sonar (IMAPS); some echosounder signals
Non-pulses	Single or multiple discrete acoustic events within 24 hours; <3 dB difference between received level using impulse vs equivalent continuous time constant	Vessel/aircraft passes; drilling; many construction or other industrial operations; certain sonar systems (LFA, tactical mid-frequency); acoustic harassment/deterrent devices; acoustic tomography sources (ATOC); some echosounder signals

Source: Southall et al., 2007. Sound types are based on characteristics measured at the source. In certain conditions, sounds classified as pulses at the source may lack these characteristics for distant receivers.

In addition to the acoustic thresholds per species, and the types and levels of sounds from proposed activities, an understanding of the functional hearing groups is an important aspect of evaluating impacts to marine mammals from sound. To date, data obtained through direct behavioral and electrophysiological measurements, and predictions based on inner ear morphology, modeling, behavior, vocalizations, or taxonomy suggest not all marine mammal species have equal hearing capabilities in terms of absolute hearing sensitivity and the frequency bands of hearing (Au and Hastings, 2008; Richardson et al., 1995; Southall et al., 2007; Wartzok and Ketten, 1999). Hearing has been directly measured in some odontocete (toothed whales) and pinniped species (Finneran, 2015; Southall et al., 2007). There are no direct measurements of mysticete hearing; therefore, hearing predictions for mysticetes (mustache or baleen whales) are based on other methods, including anatomical studies and modeling (Cranford and Krysl, 2015; Houser, Helweg, and Moore, 2001; Ketten, 2014; Ketten and Mountain, 2011; Ketten and Mountain, 2014; Parks et al., 2007), vocalizations (Au and Hastings, 2008; Richardson et al., 1995; Wartzok and Ketten, 1999), and taxonomy and behavioral responses to sound (Dahlheim and Ljungblad, 1990; Reichmuth, 2007).

To better reflect marine mammal hearing capabilities, Southall et al. (2007) recommended that marine mammals be divided into functional hearing groups based on measured or estimated functional hearing ranges (Table 4.3.2-11). A study by Ciminello et al. (2012) showed some differences in frequency ranges for marine mammal hearing groups from the Southall et al. (2007) study, and also separated pinniped hearing groups into phocid (earless) and otariid (eared) in addition to creating marine carnivore hearing groups (Table 4.3.2-11). To be conservative, the following analyses will use the broadest estimated auditory bandwidth (Table 4.3.2-11) described for a given functional hearing group. For example, the harbor porpoise has an estimated auditory bandwidth between 20 Hz and 180 kHz, or between 100 Hz and 200 kHz, depending on the study. Therefore, the extremes of those estimates, 20 Hz to 200 kHz, is the most conservative auditory bandwidth estimate for that species.

Table 4.3.2-11. Functional Marine Mammal Hearing Groups, Auditory Bandwidth[1].

Functional Hearing Group: Species that may occur in the proposed Lease Sale Area/OSRA study area	Estimated Auditory Bandwidth	
	Southall et al. (2007)	Ciminello et al. (2012)/ Finneran and Jenkins (2012)
Low-frequency (LF) cetaceans (mysticetes): humpback whale, blue whale, minke whale, fin whale, gray whale, sei whale, north Pacific right whale	7 Hz to 22 kHz	5 Hz to 30 kHz
Mid-frequency (MF) cetaceans (odontocetes): beluga whale, killer whale, Pacific white-sided dolphin, Cuvier's beaked whale, Baird's beaked whale, Stejneger's beaked whale	150 Hz to 160 kHz	50 Hz to 200 kHz
High-frequency (HF) cetaceans: harbor porpoise, Dall's porpoise	200 Hz to 180 kHz	100 Hz to 200 kHz
Phocids in water (harbor seal)	75 Hz to 75 kHz	50 Hz – 80 kHz
Phocids in air	75 Hz to 30 kHz	75 Hz – 30 kHz

Functional Hearing Group: Species that may occur in the proposed Lease Sale Area/OSRA study area	Estimated Auditory Bandwidth	
	Southall et al. (2007)	Ciminello et al. (2012)/ Finneran and Jenkins (2012)
Otariids in water (Steller Sea Lions, Northern Fur Seals), Sea Otters	75 Hz to 75 kHz	100 Hz to 40 kHz
Otariids and Sea Otters (in air)	75 Hz to 30 kHz	100 Hz to 30 kHz

Note: [1]Estimated Lower to Upper Frequency Hearing Cut-Off.

Finneran and Jenkins (2012) and 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 (continuous) and impulsive noise for marine mammals (Tables 4.3.2-12 and 4.3.2-13).

Table 4.3.2-12. Impulsive Criteria and Thresholds for Marine Species

Group	Species	Onset Mortality	Onset Slight Lung Injury	Onset Slight GI Tract Injury	Onset PTS	Onset TTS	Behavioral (for ≥2 pulses/24 hours)	Non-Explosive Impulsive Sources (NMFS† Level A)*	Non-Explosive Impulsive Source (NMFS† Level B)*
LF Cetaceans	All mysticetes				187 dB SEL (Type II weighted) or 230 dB Peak SPL	172 dB SEL (Type II weighted) or 224 dB Peak SPL	167 dB SEL (type II weighted)	180 dB SPL	160 dB SPL
MF Cetaceans	Most delphinids, beaked whales, medium- and large-toothed whales				187 dB SEL (Type II weighted) or 230 dB Peak SPL	172 dB SEL (Type II weighted) or 224 dB Peak SPL	167 dB SEL (type II weighted)	180 dB SPL	160 dB SPL
HF Cetaceans	Porpoises	Note 1	Note 2	237 dB Peak SPL (104 psi)	161 dB SEL (Type II weighted) or 230 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)	harbor 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 SPL	160 dB SPL
Otariidae (in water)	Sea lions and fur seals†				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 SPL	160 dB SPL
Mustelidae (in water)	Sea otters†							190 dB SPL	160 dB SPL

Notes: 1: $= \mathbf{91.4}\boldsymbol{M}^{-3}\left\{\mathbf{1}+\frac{\boldsymbol{D_{Rm}}}{\mathbf{10.081}}\right\}^{-2}\boldsymbol{Pa}-\boldsymbol{sec}$, where M = mass of animals in kg and DRM = depth of receiver (animal) in meters.

2: $= \mathbf{39.1}\boldsymbol{M}^{-3}\left\{\mathbf{1}+\frac{\boldsymbol{D_{Rm}}}{\mathbf{10.081}}\right\}^{-2}\boldsymbol{Pa}-\boldsymbol{sec}$, where M=mass of animals in kg and DRM = depth of receiver (animal) in meters.

* All measurements are expressed as rms. RMS of 90% of the energy under the envelope, per NMFS Office of Protected Resources.

†Sea otters are a USFWS-managed species. Broad sea otter acoustic thresholds for harassment determination have not yet been set. However, in a recent incidental take permit the USFWS used 160 dB re 1 μPA (rms) threshold for Level B harassment, and 190 dB re 1 μPA (rms) for Level A harassment (USFWS, 2014j).

Source: Ciminello et al. (2012), adapted from Table 5.

Table 4.3.2-13. Non-Impulsive Criteria and Thresholds for Marine Species

Group	Species	Physiological Criteria*		Behavioral Criteria
		Onset PTS	Onset TTS	
LF Cetaceans	All mysticetes	198 dB SEL (Type II weighted)	178 dB SEL (Type II weighted)	Mysticete weight function (Type I weighted)
MF Cetaceans	Most delphinids, beaked whales, medium- and large-toothed whales	198 dB SEL (Type II weighted)	178 dB SEL (Type II weighted)	Odontocete Dose Function (Type I weighted)
HF Cetaceans	Porpoises	172 dB SEL (Type II weighted)	152 dB SEL (Type II weighted)	Odontocete Dose Function (Type I weighted)

Group	Species	Physiological Criteria*		Behavioral Criteria
		Onset PTS	Onset TTS	
Harbor Porpoise	Harbor Porpoise			120 dB SPL, unweighted
Phocidae (in water)	All phocid seals	197 dB SEL (Type I weighted)	183 dB SEL (Type I weighted)	Odontocete Dose Function (Type I weighted)
Otariidae (in water)	Sea lions and fur seals	220 dB SEL (Type I weighted)	206 dB SEL (Type I weighted)	Odontocete Dose Function (Type I weighted)
Mustelidae (in water)	Sea otters			

Note: *PTS and TTS in dB re 1 μPa^2 s
Source: Ciminello et al. (2012), adapted from Table 7.

Though PTS and TTS may be measured using the SPL or SEL metrics, NMFS has historically used and currently uses dB re 1µPa SPL_{rms} to determine harassment as defined under the MMPA. The noise levels NMFS uses are 190 and 180 dB re 1 µPa @ 1 m for Level A harassment threshold criteria, where permanent injury to marine mammal ear structures could occur (Tables 4.3.2-8 and 4.3.2-9). These noise levels may extend tens of meters from a noise source before attenuating and are typically produced by seismic surveys, ancillary activities, and icebreaking. The 160 and 120 dB re 1 µPa @ 1 m noise levels are used as the noise threshold for the onset of Level B harassment with respect to impulsive and non-pulsed noises respectively (Tables 4.3.2-8 and 4.3.2-9) (NOAA, 2014a). These noises may begin at the source, such as with drilling, construction, and pile driving, and may extend out for several miles depending on the activity and source levels (NOAA, 2014a).

The typical sound source levels of activities associated with the Proposed Action are displayed in Table 4.2.5-1. Typical sound source levels will be used to evaluate potential impacts to marine mammal species throughout Chapter 4.

Active Acoustic Sound Sources

The E&D Scenario presented in Section 2.4 identifies several types of surveys that would utilize active acoustic sound sources, including 2D and 3D marine seismic surveys, OBC and OBN seismic surveys, geohazard surveys, and gravity surveys. The potential for each of these to be used in Cook Inlet is outlined in Table 2.4.3-2 and briefly summarized in the following section, along with the types of active acoustic sound sources utilized by each type of survey and their anticipated effects on marine mammals. Species-specific impacts from these activities are discussed later in this chapter.

Marine Seismic Surveys

Lessees use marine seismic survey data to determine the optimal location for drilling the first well on their lease acreage. Deep-penetration seismic surveys are the primary tool used to identify prospective locations to drill for subsurface deposits of crude oil and natural gas.

Airguns are fired at short regular intervals, so the arrays emit pulsed rather than continuous sound. While most of the energy is focused downward and the short duration of each pulse limits the total energy into the water column, the sound can propagate horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994). The sound source level (0-p) associated with typical marine seismic surveys ranges between 233 and 255 dB re 1 µPa @ 1 m with most of the energy emitted between 10 and 120 Hz, in close proximity to the airgun array, but quickly attenuates.

Most airgun noise is focused downward from the airgun array, but noise will radiate horizontally from firing airgun arrays; the sound attenuates as it reflects off the seafloor and water surface. 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 (Greene and Moore, 1995; Blackwell et al., 2013). Long-term exposure to airgun noise is suspected to have effects on marine mammals, including hearing loss and elevated stress levels; it could also elicit behavioral changes (Richardson, 1995; Richardson and Würsig, 1995). However the likelihood of repeated exposures to pulsed noise from active airgun arrays remains very low since seismic vessels typically travel at 4-5 knots/hr, limiting the potential exposure to only a few pulses before the airgun noise drops below the TTS or PTS decibel level thresholds (Table 4.3.2-8).

Heath *et al*. (2014) conducted a sound source verification of the seismic arrays used by SAE in Lower Cook Inlet in recent years, including 2015. Their measured distances to the 160 dB isopleth for the 440-cubic inch array, the 1,760-cubic-inch array in shallow water, and the 1,760-cubic-inch array in deeper water were 3.05, 4.27, and 6.83 kilometers, respectively (Table 4.3.2-14). NMFS interpreted these effects on all marine mammals as falling within the MMPA definition of Level B (behavioral) harassment. The impacts were deemed to be minor because NMFS did not expect measurable effects or changes to marine mammal populations or rookeries, mating grounds, and other significant areas (NMFS, 2015b).

Table 4.3.2-14. Distances to NMFS Harassment Thresholds from Seismic Airgun Arrays used in 2015.

Source & Depth	Distance to 190 dB	Distance to 180 dB	Distance to 160 dB
440 cubic inch array (very shallow)	50 m (0.03 mi)	182 m (0.11 mi)	3.05 km (1.90 mi)
1,760 cubic inch array (shallow)	830 m (0.52 mi)	1.53 km (0.95 mi)	4.27 km (2.65 mi)
1,760 cubic inch array (deep)	880 m (0.55 mi)	1.84 km (1.14 mi)	6.83 km (4.24 mi)

Source: NMFS, 2015b

Ocean-bottom node (OBN) surveys may use an acoustical positioning system (or “pinger” system) to position and locate nodes placed on the seafloor. The pinger system consists of a vessel-mounted transceiver and transponders that attached to nodes. The transceiver uses sonar to communicate with the transponders, which in turn emit a response pulse. A pinger system recently used by SAE in Cook Inlet consisted of a transceiver that generated sonar at transmission source levels of 197 dB re 1 μPa (rms) at frequencies between 35 and 55 kHz and a transponder that produced short pulses of 184-187 dB re 1 μPa (rms) at frequencies also between 35 and 35 kHz (NMFS, 2015h). While pinger systems generate sound source levels that exceed the NMFS’ MMPA definition of Level A take, the sound produced attenuates rapidly. As a result of rapid attenuation, the area ensonified at or above the Level A threshold is very small (0-20 ft) and much of it is occupied by the vessel (NMFS, 2015h). In recent evaluations of seismic activities in Cook Inlet where pinger systems have been used, NMFS has concluded that marine mammals would likely avoid the transceiver vessel at such short distances simply due to vessel disturbance (NMFS, 2013d, 2015h).

The effects of sounds from prolonged or repeated airgun and sonar pulses on marine mammals might include one or more of the following: tolerance or habituation, masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, or non-auditory effects (Richardson, 1995). The primary amplitude frequency range produced by airguns and airgun arrays (between 5 and 300 Hz) and pinger systems would occur within the auditory bandwidth of marine mammals in the proposed Lease Sale Area (Table 4.3.2-11). Although the sound source levels (0-p) associated with typical marine seismic surveys (233 to 250 dB re 1 μPa @ 1 m) and pinger systems (184-187 dB re 1 μPa @ 1 m) are above the acoustic threshold for Level A and Level B harassment determination, based on the expected implementation of standard mitigation measures required by NMFS and USFWS permits, such as, but not limited to, PSO lookouts, Ramp-up/Shutdown procedures, and marine mammal avoidance protocols. Consequently, minor effects on marine mammals in Cook Inlet are expected from marine seismic surveys, mostly evidenced by avoidance of operating airgun arrays and pinger systems.

Geohazard Surveys

The suite of equipment used during a typical geohazard hazards survey consists of single-beam and multibeam echosounders, which provide water depths and seafloor morphology; a side-scan sonar that provides acoustic images of the seafloor; a subbottom profiler that provides 20 to 200 m (66 to 656 ft) subseafloor penetration with a 6- to 20-cm (2.4- to 7.9-in.) resolution; a bubble pulser or boomer with 40 to 600 m (131 to 1,969 ft) subseafloor penetration; and a multichannel seismic system with 1,000 to 2,000 m (3,280 to 6,562 ft) subseafloor penetration.

Typical acoustic characteristics of these sources are summarized in Richardson et al. (1995) as follows:

- Echosounders: 180 to 200 dB re 1 µPa @ 1 m between 12 and 60 kHz. Multibeam and single-beam echosounder noise should be audible to marine mammals that hear in low-, mid-, and high-frequency sound spectrums. Depending on the species, there could be avoidance behavior, physiological effects, or no effects.
- Side-scan sonar: 220 to 230 dB re 1 µPa @ 1 m between 50 and 500 kHz. Noises in the frequency range used by sonar should be inaudible to many marine mammals with low-frequency hearing and to all marine mammals that hear in the mid- to high-frequency sound spectrum, such as harbor porpoises, beluga whales, and killer whales. Effects of sonar noise on marine mammals in the proposed Lease Sale Area could include behavioral effects, physiological effects, or no effects, depending on species.
- High-resolution profilers, including subbottom profilers: 200 to 230 dB re 1 µPa @ 1 m between 400 Hz and 30 kHz, and bubble pulsers or boomers: 200 dB re 1 µPa @ 1 m below 1 kHz. High-resolution profiler noise should be audible to marine mammals that hear in low-, mid-, and high-frequency sound spectrums and may cause avoidance behavior, physiological effects, or no effects, depending on species.

Echosounders and subbottom profilers generally are hull-mounted. All other equipment usually is towed behind the vessel. The towed multichannel seismic system consists of an acoustic source that may be a single small (10 to 65 in^3) airgun or an array of two or four small (10 in^3) airguns. The source array is towed approximately 3 m (9.8 ft) behind the vessel with a firing interval of approximately 12.5 m (41 ft), or every 7 to 8 seconds. A single 300- to 600-m (984- to 1,969-ft), 12- to 48-channel streamer with a 12.5-m (41-ft) hydrophone spacing and tail buoy is the passive receiver for the reflected seismic waves.

It is expected that many marine mammals would move away in response to approaching airguns or vessels before they would be close enough to be physically affected by the vessel or airgun (NMFS, 2015b). Mitigations such as, but not limited to, PSO lookouts, ramp-up/shutdown procedures, and marine mammal avoidance protocols, should limit the impacts of geohazard surveys to a minor level of effects on marine mammals in Cook Inlet.

Drilling and Equipment Noise

Underwater marine sounds associated with drilling operations include strong tonal components at low frequencies (averaging 10 to 500 Hz) and, in some cases, infrasonic frequencies (Richardson et al., 1995; USDOI, MMS, 2000). Drillships can be expected to produce noise from drilling and maintenance operations. Sound and vibration from rig generators and drilling machinery on board a drillship are transmitted through the hull, which is coupled to the water (Richardson et al., 1995). Marine sounds emitted by drilling rigs were found to be dominated by a mix of tones thought to be related to the drill string rotation rate. When drilling, the drill string represents a long vertical sound source. Piling and conductor pipe driving may or may not occur during drilling and development but can produce broadband impulsive SPL_{p-p} up to 250 dB re 1 µPa @ 1 m (see Table 4.2.5-1).

Noise levels vary with the type of drilling rig and water depth. Drillships produce some of the highest levels of continuous underwater noise because the hull containing the rig generators and drilling machinery is well coupled to the water. Still noise generated from drillships during drilling and in the absence of thrusters should occur between 154 and 176 dB re 1 µPa @ 1 m (Greene, 1986; Nedwell, Needham, and Edwards, 2001), and be too low to elicit a PTS among any marine mammals. The use of thrusters can elevate sound source levels from a drillship to approximately 188 dB re 1 µPa @ 1 m (Nedwell and Edwards, 2004). The majority of noise from an operational drillship was found to be in the 40 - 600 Hz band when measured at a range of 0.5 - 2 km (0.3 - 1.2 mi). At a range of 5 km (3 mi), there was no perceptible noise above ambient (Nedwell and Edwards, 2004). Underwater noise from jack-up rigs standing on metal legs and from production platforms would be expected to be much lower because of the smaller equipment surface area contacting the water; most machinery would be on the rig deck well above the water surface so there would be no propulsion noise.

Drilling operations generate continuous underwater sounds that could affect species in the proposed Lease Sale Area. Richardson (1995), numerous other studies, and decades of marine mammal monitoring have shown that OCS drilling produces continuous noise that leads to avoidance by many, but not all, marine mammals with no quantifiable lingering effects (USDOI, BOEM, 2015d).

Exposure to drilling and equipment noise may result in tolerance, avoidance, or displacement of marine mammals around drilling operations (NMFS, 2015b). While protected species observers (PSOs) are expected to monitor the presence of marine mammals near drilling operations, there may not be shutdown mechanisms in place for marine mammals that enter isopleths containing Level A and Level B harassment sound levels. However, because drilling and equipment noise will be continuous, marine mammals are not expected to enter into an area where they would suffer from acoustic harassment (NMFS, 2015b). Furthermore, as previously stated, noise levels capable of Level A Harassment are highly unlikely, and even if they could occur, the respective area of effects would restricted to the immediate vicinity of the drillship or platform, most likely less than 30 meters.

The location, timing, and amount of specific actions have not been determined and would be evaluated as exploration, development, and production plans are submitted to BOEM. Individual whales, seals, and sea otters likely would avoid activities that bothered them; the distances vary according to the individual and site-specific conditions (e.g., activity type, duration, timing). These activities, however, would be subject to mitigation measures that would help avoid adverse effects on marine mammals, critical habitat, and biologically important areas. Noise associated with production platforms and pipeline operations vary depending on the type and extent of activities occurring. Machinery noise from fixed production platforms can be continuous or transient, with intensities that vary by platform type and water depth. Gales (1982) reported underwater noise from fixed structures can vary from approximately 20 to 40 dB above background levels within a 30 to 300 Hz frequency spectrum at a distance up to 30 m (98 ft).

Overall effects to marine mammals from drilling and equipment noise are anticipated to be short-term with highly localized minor levels of effects. Drilling could not produce noise levels sufficient for Level A harassment to occur, though the 160 dB needed for Level B harassment could occur in immediate proximity to the drillship or drilling platform. The impacts to marine mammals from the drilling of production wells and associated equipment noise during the development phase are expected to be similar to those described for the drilling of exploration wells and associated equipment noise in the exploration phase. However, the number of wells that could be drilled simultaneously is expected to increase during production. Because of the low likelihood of crossing the NMFS acoustic harassment criteria thresholds, the transient nature of drilling, and the standard suite of NMFS mitigations (PSOs posted, start-up, ramp-down, etc.) the effects of drilling on marine mammals should be negligible to minor.

Pile Driving

Pile driving is a technique used to fix production platforms to the seafloor. Greene et al. (1995) reviewed the topic of pile driving noise production in the marine environment, noting SPLs of 131 to 135 dB re 1 µPa @ 1 m from pile driving near Prudhoe Bay, Alaska. More recently, Blackwell (2005) recorded pile driving noises of 190 dB re 1 µPa @ 1 m across a 100 Hz to 2 kHz frequency range from pile driving activities at the Port MacKenzie docks in upper Cook Inlet. Typically the decibel levels from the Port MacKenzie dock modification work dropped to ambient levels of 115 to 133 dB re 1 µPa within approximately 1 km (0.6 mi) from the noise source. The low-frequency percussive noise produced by pile driving could be detectable to marine mammals several kilometers from the activity. Pile driving creates frequencies between 20 Hz and 12 kHz, with pulse energy peaks in the range of 50 Hz to 2 kHz (Blackwell, 2005; Illinworth & Rodkin, Inc., 2007). The frequencies produced by pile driving will be audible to sea otters (Ghoul and Reichmuth, 2012a); seals; and low-, mid-, and high-frequency cetaceans (Table 4.3.2-11). Marine mammals would likely have behavioral responses to such noises such as avoidance or skittishness. Harbor porpoises showed a strong avoidance response within 20km distance to pile driving (Dähne et al., 2013). Temporary and even permanent threshold shifts caused by sound from pile driving are possible, if marine mammals do not avoid the radius around the activity with sound exposure levels predicted to cause TTS and PTS. Both TTS and PTS were modeled to have occurred to 24 tagged harbor seals exposed to pile driving during the construction of a wind farm in the North Sea (Hastie et al. 2015).Since pile driving mostly occurs in the 100-500 Hz frequency band, if a TTS or PTS incident were to actually occur only a very small portion of the very bottom fraction of a marine mammals audible bandwidth could be affected. The presence of PSOs and other mitigations should prevent a TTS or PTS effect to marine mammals in the area. Furthermore marine mammals generally avoid areas that have been ensonified to the extent that the noise levels could produce actual harm. For this reason the most probably effect to marine mammals from pile driving would be low level noise, resulting in a ≥1 km (0.6 mi) avoidance of the area for the duration of pile-driving activities. Lastly several offshore platforms have been constructed in Cook Inlet since the 1960s, many without NMFS mitigations, with no noticeable adverse effects having been reported among Cook Inlet marine mammals.

Other Construction Noises (e.g., dredging, pipeline installation)

Richardson (1995) noted that dredges, which can be used to create artificial islands, 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 dredges can be strong sources of continuous noise in nearshore regions, and 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 in the Beaufort, 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. Meanwhile, 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. Although there are no bowhead whales in the proposed Lease Sale Area, other baleen whales may react similarly. Bryant, Lafferty, and Lafferty (1984 as cited in Richardson, 1995) found wintering gray whales avoided a lagoon in Baja California for several years while dredging activities occurred. The presence of minke whales was negatively correlated with the presence of vessels (included construction vessels which consisted of dredgers, pipe-laying vessel, barges and tugs) during the construction of an underwater gas pipeline through a bay on the northwest coast of Ireland (Anderwald et. al., 2013). Australian sea lions and New Zealand fur seals showed no signs of disturbance reactions, despite the relative closeness of dredging to popular haul-out sites (EPA, 2007).

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. Generally speaking, construction noises for pipelines, drilling platforms, etc. produce acoustic disturbances to a localized area that could affect marine mammals or their prey for the duration of the construction activity.

Vessel Noise

Vessels associated with the Proposed Action may operate year-round as much of the proposed Lease Sale Area remains ice-free during the winter. Marine mammals may be exposed to vessels when seasonal distribution and habitat selection overlaps in time and space with proposed exploration vessel activities. For OCS oil and gas exploration, operation 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, and operation of MODUs as well as the construction and operation of production platforms and the associated supply vessels.

Vessel noise is one of the main contributors to overall noise in the sea (CSA Ocean Sciences Inc., 2014; Gordon and Moscrop, 1996; Normandeau Associates, Inc., 2012; NRC, 2003a). Survey vessels, MODUs, and barges would contribute to the overall noise environment by transmitting noise through air and water. The category and type of vessels operating during development and production will heavily depend on the phase of activity. Smaller supply vessels transiting to and from the proposed Lease Sale Area will produce transient sounds in the 128 to 158 dB re 1 µPa @ 1 m range, with predominant low-frequency components less than 1,000 Hz. If a supply vessel remains on standby, it will produce low continuous sound levels. During exploration seismic surveys, smaller support vessels are assumed to make occasional trips (once to twice per week) to refuel and resupply (likely operating out of Homer or Nikiski). During exploration drilling, operations would be supported by helicopters and supply vessels. Support vessel traffic would be expected to occur one to three times (trips) per week, also out of Homer or Nikiski. OCS construction (i.e., platform and pipeline installation), development drilling operations, and normal production operations would be supported by helicopters and supply vessels from existing facilities located in Homer or Nikiski. Support vessel traffic is estimated to consist of one to three trips per platform per week from Homer or Nikiski. Typical responses of marine mammals to small vessel noise are behavioral reactions or no visible reaction, depending on circumstances. Small vessels of the type used to hunt or harass marine mammals can elicit greater responses than vessel types that are not used for such activities (Richardson et al., 1995).

Larger supply vessels may be required in more open water environments and these can produce sound levels of 155 to 190 dB re 1 µPa @ 1 m. Large vessels (>85 m (279 ft)) 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. Noises at 2 Hz and below are outside the audible range for most marine mammals and should have negligible effect on marine mammals; however, noises above 5 Hz would be heard by marine mammals. Such noise could produce avoidance reactions. Additionally, even if the frequencies of vessels are outside of the hearing range of marine mammals, the physical presence of vessels may cause impacts.

Specific operations may require specialized vessels that produce higher sound source levels than supply vessels; however, these sources represent short duration activities that occur sporadically throughout development or during a specific finite activity. These specific activities include development and production operations, pile/conductor driving operations, and tug/barge operations. Tug and barge activities can produce SPL_{rms} of 171 dB re 1 µPa @ 1 m. If barges are used to transport drill cuttings and spent drilling fluid from production wells, a dedicated barge could make one to two trips per week to an onshore disposal facility during drilling operations.

Reactions of marine mammals to vessels often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction of movement (NMFS, 2013c). Past experiences with vessels are important in determining the degree and type of response elicited from an animal-vessel encounter. Whale reactions to slow-moving vessels are less dramatic than their reactions to faster or erratic vessel movements. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Heide-Jørgensen et al., 2003; Richardson et al., 1995; Wartzok et al., 1989).

The presence and movements of ships in the vicinity of seals can elicit disturbed behavior (Ferland and Decker, 2005; Henry and Hammill, 2001; Jansen et al., 2010; Shaughnessy, Nicholls, and Briggs, 2008), possibly causing seals to abandon preferred breeding habitats in high traffic areas (Mansfield, 1983; Reeves, 1998; Smiley and Milne, 1979). Depending on circumstance, seals may not respond to vessel traffic, or may respond by deflection from the noise source, avoidance behavior, short-term vigilance behavior, or short-term masking behavior (NMFS, 2015b). Overall, vessel noise does not seem to strongly affect pinnipeds that are in the water (Richardson et al., 1995). Because sea otters spend much of their time at the surface resting, grooming, and nursing their young, they can be disturbed by the presence of vessel traffic and noise. Curland (1997) reported that sea otters in areas of disturbance by power boats, divers, and kayaks engaged in greater amounts of travel than they did in areas without disturbance.

4.3.6.4. Physical Presence, Including Lights

Physical anthropogenic presence resulting from the Proposed Action can impact a variety of marine mammal species. Impacts from physical presence can occur from increased marine or aircraft traffic (discussed in a later section), newly erected man-made structures or work camps, or as a consequence of increased social presence and human interaction (USDOI, MMS, 2003). Section 4.2.7 discusses the estimated number, duration, and type of surveys that will result in potential impacts from physical presence of vessels as part of the Proposed Action.

The E&D Scenario includes an estimate of one to two seismic surveys, four to five geohazard surveys, and four to five geotechnical surveys. The duration of the surveys would depend on numerous factors that are discussed in Section 4.2.7. Physical presence disturbances are expected to be highest during the exploration phase from seismic surveys and the presence of drilling rigs, due to relatively higher levels of oil and gas activities during this phase. Effects from the physical presence of Proposed Action activities are difficult or impossible to distinguish from the effects from noises from activities associated with the Proposed Action. For example, aircraft, vessels, platforms, and drill rigs all have a physical presence in the environment but also emit noise. As such, the suite of disturbance behaviors resulting from noise are largely the same as those from physical presence; an in-depth discussion of these impacts are described in Sections 4.3.6.1 and 4.3.6.7. These behaviors include avoidance, attraction, increased swimming speed, and dive time, all of which may result in reduced fitness.

The presence of seismic vessels is temporary, and discussed in further detail in Section 4.3.6.5. During exploration drilling and delineation, MODUs would be present in the proposed Lease Sale Area for a short period of time.

Presently, oil and gas infrastructure exists in the proposed Lease Sale Area, along with numerous shipping routes and a regular flow of vessel traffic. It is unlikely the additional OCS infrastructure estimated in the E&D Scenario would affect marine mammals’ behavioral patterns, considering the level of existing amounts of development and anthropogenic disturbance in Cook Inlet, Alaska.

It should be noted that the mere presence of a vessel usually isn’t sufficient to draw a response from a marine mammal. As has been repeatedly noted (BOEM, 2015e), most often the relationship between boating and marine mammals correlates with proximity of the vessel to the marine mammal and the context of the vessels activity. For instance pinnipeds like harbor seals may approach small vessels in areas where they aren’t hunted such as a maritime national park, but through time, learn to avoid small vessels in areas where they are regularly hunted. NMFS mitigations prohibiting vessels from approaching marine mammals should reduce the effects of vessel presence to marine mammals to negligible levels of effect.

4.3.6.5. Trash and Debris (Including Non-Hazardous Domestic Waste)

The potential for trash and debris to enter the marine environment under the proposed E&D Scenario is discussed in detail in Section 4.2.8. Marine debris poses two types of potentially negative impacts to marine biota, including marine mammals: entanglement and ingestion (USDOI, BOEM, 2012b). Records suggest that entanglement is a far more likely cause of mortality to marine mammals than ingestion-related interactions (USDOI, BOEM, 2012b). Entanglement records for marine mammals show that entanglement is most common in pinnipeds, less common in mysticetes, and rare among odontocetes (Laist, Coe, and O’Hara, 1999). The Proposed Action is not expected to result in a large addition of entanglement hazards to the waters of Cook Inlet from debris or trash. The discharge of certain trash and debris is prohibited (33 CFR 151.51 to 151.77) unless it is passed through a comminutor. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste. Considering BOEM guidance and the USCG and EPA regulations requiring operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste, it is unlikely large amounts of trash and debris from E&D Scenario activities would be released into the marine environment.

4.3.6.6. Vessel Traffic

All vessels involved in offshore oil and gas exploration activities would operate out of existing shore bases as described in the E&D Scenario. A detailed discussion on vessel traffic within the four phases of development can be found in Section 4.2.9. Vessel traffic is expected to occur during all four phases of development (exploration, construction, production, and decommissioning) (see Table 4.2-2) and is not discussed separately by phase in this section. Vessel traffic may occur year-round because the proposed Lease Sale Area remains relatively ice-free in the winter months due to the strong currents. In the event of adverse sea conditions, helicopters would supplement resupply and personnel transport.

Marine mammals may collide with vessels or their propellers, or become entangled in oil and gas-related equipment. Many marine mammal species are vulnerable to collisions with moving vessels (Douglas et al., 2008; Laist et al., 2001; Pace, 2011), and the potential for striking marine mammals is a concern with increased vessel traffic (NMFS, 2014) as a result of the Proposed Action. Most reports of collisions involve large whales, but collisions with smaller species also occur (Van Waerebeek et al., 2007). There are reports of collisions between moving vessels and most of the species that occur within the proposed Lease Sale Area, particularly the fin whale. Vessel traffic can also impact spatial distribution, movement pattern, and reduced the abundance of marine mammals (Sorensen et al., 1984; Thiel et al., 1992).

Evidence suggests that a greater rate of mortality and serious injury to marine mammals correlates with greater vessel speed at the time of a ship strike (Laist et al., 2001; Vanderlaan and Taggart, 2007, as cited in Aerts and Richardson, 2008). Vessels transiting at speeds >10 kn present the greatest potential hazard of collisions (Jensen and Silber, 2004a; Silber et al., 2009). Vanderlaan and Taggart (2007) demonstrated that the greatest rate of change in the percent chance of a lethal injury to a large whale occurs between vessel speeds of 8.6 and 15 kn. While most seismic survey operations occur at relatively low speeds (1 to 5 kn), large vessels are capable of transiting at up to 16.5 kn and operate in periods of darkness and poor visibility (USDOI, BOEM, 2015a). In addition, large vessels cannot perform abrupt turns when traveling and cannot slow speeds over short distances to react to encounters with marine mammals (USDOI, BOEM, 2015a). A 4-year study of humpback whale sightings in conjunction with cruise ships in southeastern Alaska found that vessel speed influences the encounter distance between large ships and whales (Gende et al., 2011). Specifically, Gende et al. (2011) found a clear decrease in encounter distance with increasing ship speed over the range of 7 to 17 kn.

In cases where vessels actively approach marine mammals (e.g., whale- or dolphin-watching boats), scientists have documented animals exhibiting altered behavior such as increased swimming speed, erratic movement, and active avoidance behavior (Acevedo, 1991; Baker and MacGibbon, 1991; Bursk, 1983; Constantine, Brunton, and Baker, 2003; Trites and Bain, 2000; Williams, Trites, and Bain, 2002), reduced blow interval (Richter, Dawson, and Slooten, 2003), disruption of normal social behaviors (Lusseau, 2003, 2006), and the shift of behavioral activities, which may increase energetic costs (Constantine, Brunton, and Baker, 2003, 2004). A detailed review of marine mammal reactions to ships and boats is available in Richardson et al. (1995).

Increased vessel traffic as a result of the Proposed Action is anticipated, and with the expected increase in vessel traffic, there is a greater possibility of vessels striking marine mammals. Vessels associated with BOEM-authorized activities would have a transitory presence in any specific location, except for drilling sites, with a likely limited effect on marine mammals because the animals will likely avoid vessels in high-traffic areas (Richardson, 1995; Richardson et al., 1995).

4.3.6.7. Aircraft Traffic and Noise

During the exploration, development, and production phases, helicopters will support operations by transporting supplies and personnel. BOEM expects helicopters to make one to three flights per day during exploration drilling, and one to three flights per day per platform during construction, development, and production activities from shore bases in Kenai, Nikiski, Homer, or Anchorage. All aircraft would be expected to follow Federal Aviation Administration (FAA, 2004) guidance, which recommends a minimum altitude of 610 m (2,000 ft) when flying over noise sensitive areas such as national parks, wildlife refuges, and wilderness areas. Pinniped haulout locations occur on coastal areas that are often within such sensitive areas. Likewise, most of the coastal areas along lower Cook Inlet are uninhabited wilderness areas, state refugees or parks, etc. Maintaining a 610 m elevation in those areas would protect coastal haulouts for pinnipeds and any cetaceans close to shore.

In addition to the FAA recommendations for minimum aircraft altitudes, NMFS has traditionally required a minimum altitude of 1,000 – 1,500 ft. (305 - 458 m.) for operations other than takeoffs, landings, or emergencies (NMFS, 2014a; 79 *FR* 54397, September 11, 2014; NMFS, 2013d).

Helicopters generate noise from their engines, airframe, and propellers. The dominant tones generally are below 500 Hz (Richardson et al., 1995). Richardson et al. (1995) reported that received SPLs in water from aircraft flying at altitudes of 152 m (500 ft) were 109 dB re 1 μPa for a Bell 212 helicopter and 101 dB re 1 μPa for a small fixed-wing aircraft such as a BN Islander. Penetration of aircraft noise into the water is greatest directly below the aircraft; at angles >13° from vertical, much of the sound is reflected and does not penetrate into the water (Richardson et al., 1995). The duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 152 m (500 ft) that is audible in air for 4 minutes may be detectable underwater for only 38 seconds at 3 m (10 ft) depth and for 11 seconds at 18 m (59 ft) depth (Richardson et al., 1995).

The physical presence of low-flying aircraft can disturb marine mammals, particularly individuals resting on the sea surface (USDOI, BOEM, 2012b). Observations made from low-altitude aerial surveys report highly variable behavioral responses from marine mammals ranging from no observable reaction to diving or rapid changes in swimming speed/direction (Efroymson et al., 2000; Smultea et al., 2008).

NMFS and the USFWS assume low-flying aircraft could result in Level B harassment (Scholik-Schlomer et al., 2011). Helicopters in support of oil and gas activities are unlikely to disturb marine mammals since they typically fly at high altitudes (USDOI, BOEM, 2012b). Potential IPFs to marine mammals from aircraft traffic and noise include noise and physical (visual) disturbance.

Helicopter traffic may result in brief behavioral responses, but impacts are not expected to be substantial because of the operational altitude requirements, and the limited amount of the air traffic. Neither well locations nor the location of potential helicopter support bases are known at this programmatic stage; however, it is expected that helicopters would follow the same route each day. Based on the short duration of potential exposure to aircraft-related noise and visual disturbance at any given location when the helicopter passes over, it is expected that effects on marine mammals would be limited to brief behavioral responses.

In a review of aircraft noise effects on marine mammals, Luksenburg and Parsons (2009) determined that the sensitivity of whales and dolphins to aircraft noise may depend on the animals' behavioral state at the time of exposure (e.g., resting, socializing, foraging, traveling) as well as the altitude and lateral distance of the aircraft to the animals. While resting animals seemed to be disturbed the most, low-flying aircraft with close lateral distances over shallow water elicited stronger disturbance responses than higher-flying aircraft with greater lateral distances over deeper water (Luksenburg and Parsons, 2009).

Impacts may be mitigated by measures such as altitude restrictions commonly seen in Incidental Take Regulations and IHAs. For example, helicopters are expected to maintain an altitude of 610 m (2,000 ft), an altitude to which marine mammals do not typically show disturbance reactions.

4.3.6.8. Accidental Oil Spills and Gas Releases

Appendix A provides detailed technical information used by BOEM to develop the set of assumptions on which the analysis of oil spills and gas releases is based for the entire life of the E&D Scenario. For the purpose of this analysis, BOEM describes oil spills and gas releases in terms of the following two general activity categories:

- Small spills (<1,000 bbl)
- Large spill (≥1,000 bbl)/Gas release

Section 4.2.14 summarizes the estimated spill sizes and volumes for the duration of the Proposed Action. More detailed descriptions of estimated spills and their potential volumes over each phase of the oil and gas activities are presented in Appendix A.

Catastrophic events such as very large oil spills are rare, but may have substantial effects on marine mammals and their prey through changes to spawning or migration patterns, direct mortality, or potential long-term sublethal impacts (Marty et al. 1997; Moles, Rice, and Norcross, 1994; Murphy et al. 1999; Geraci and St. Aubin, 1982, 1990). Since they are rare and not a foreseeable IPF from any of the alternatives, very large oil spills are analyzed separately in Appendix A. Consequently they will not be discussed further in Section 4.3.6.

Small Oil Spills (<1,000 bbl)

Small spills could occur during any phase of the Proposed Action and consist of crude oil, condensate, diesel, or other refined oils. Among refined petroleum products, diesel fuel is considered to be especially toxic (Irwin et al., 1997) because it is enriched in PAHs (Clark, 1989; Craddock, 1977; National Toxicology Program, 1986).

Though much of the refined oil spilled in a small incident should volatize within a few days, the rate of weathering depends on temperature, light, and other environmental conditions. Once dispersed into the water column or settled into substrates, petroleum compounds such as PAHs and heavy metals can remain bioavailable in lower concentrations for a time and pose a risk to marine organisms (Section 4.3.5.8). Chronic exposure to diesel spills and latent contamination in the sediments for nearshore species also pose risks to marine organisms (NMFS, 2005).

Because small refined offshore oil spills dissipate rapidly, and due to their limited size, they would likely have negligible to minor effects on marine mammals. As different species of marine mammals have varying physiological reactions to oils, species-specific effects from small spills are discussed in Section 4.3.6.8.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. BOEM analyzes one large spill (≥1,000 bbl) during development, production, or decommissioning. No large spills are estimated to occur during the exploration phase. Large spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within the first 24 hours, although a small proportion of the heavier fuel components could adhere to PM in the upper portion of the water column and sink, potentially contacting marine mammals. Large spills of crude oil would persist longer in the environment and result in greater impacts than spills of refined products.

If a large oil spill were to occur, marine mammals and their habitats could be adversely impacted. Marine mammals could experience adverse effects from contact with hydrocarbons, through the following routes of exposure:

- Inhalation of liquid and gaseous toxic components of crude oil and gas
- Ingestion of oil or contaminated prey
- Fouling of baleen in mysticetes, and fur on fur seals and sea otters
- Oiling of skin, eyes, and conjunctive membranes causing corneal ulcers, conjunctivitis, swollen nictitating membranes and abrasions

Available evidence suggests mammal s vary in their vulnerability to short-term damage from surface contact with oil and ingestion (Geraci and St. Aubin, 1990; Jessup and Leighton, 1996). 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 their potential oil vulnerability. NOAA's (2013) Pinniped and Cetacean Oil Spill Response Guidelines provides an overview of effects oil on marine mammals.

Several investigators have observed various cetaceans in spilled oil, including fin whales, humpback whales, gray whales, dolphins, and pilot whales. Typically, the whales did not avoid slicks but swam through them, apparently showing no reaction to the oil. For example, during the spill of Bunker C and No. 2 fuel oil from the *Regal Sword*, researchers saw humpback and fin whales, and a whale tentatively identified as a right whale, surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts (Geraci and St. Aubin, 1990). Whales and a large number of white-sided dolphins were also observed swimming, playing, and feeding in and near the slicks, and no difference in behavior was observed between cetaceans within the slick and those beyond it. Some researchers have concluded that baleen whales have such good surface vision that they rely on visual clues for orientation in various activities. After the Exxon Valdez Oil Spill, researchers studied the potential effects of an oil spill on cetaceans. Dahlheim and Loughlin (1990) documented negligible 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. ADNR (2016) shows there have been several large spills in Cook Inlet over the years, and some of them have been much larger than the 5,100 bbl and 1,700 bbl spills assumed for a platform or pipeline respectively. In spite of the history of spills in Cook Inlet no widespread mortalities of marine mammals have been associated with such accidents.

The greatest threat from oil exposure to cetaceans and pinnipeds (excluding fur seals) is likely from the inhalation of the volatile toxic hydrocarbon fractions of fresh oil which can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin, 1990), have anesthetic effects (Neff, 1990), and cause death (Geraci and St. Aubin, 1990). However, for small spills, toxic fumes are anticipated to dissipate rapidly into the atmosphere from rapid aging of fresh refined oil, which limits potential exposure of whales to prolonged inhalation of toxic fumes. In addition to the impacts from inhalation of volatile toxic hydrocarbons in fresh oil, hypothermia will be the greatest threat to sea otters and fur seals as oil greatly reduces the insulating value of fur these species rely on for warmth (DeGange and Lensink, 1990; Doroff et al., 1993; Geraci and Williams, 1990; Mearns et al., 1999).

Spilled diesel fuel poses risks to marine mammals. Among refined petroleum products, diesel fuel is considered to be especially toxic (Irwin et al., 1997) because it is of a greater proportionate concentration of PAHs (Clark, 1989; Craddock, 1977; National Toxicology Program, 1986). Because different species of animals have different physiological reactions to diesel exposure, some invertebrate species experience high mortality while others appear unaffected. Therefore, diesel spills could have ecosystem-level impacts by altering benthic community structure (Carmen, Fleeger, and Pomarico, 1997; Millward et al., 2004), which could affect competition and food availability for higher trophic levels.

Although much of the diesel spilled in an incident is expected to volatize within a few days, the rate of weathering depends on temperature, light, and other environmental conditions. Once dispersed into the water column, or settled into substrates, petroleum compounds such as PAHs and heavy metals can remain bioavailable in lower concentrations, and still pose a risk to marine organisms that come in contact with these compounds. Chronic exposure to diesel spills and latent contamination in the sediments for nearshore species also pose risks to many marine organisms (NMFS, 2005).

Although unlikely, BOEM estimates that a well control incident of a single well could result in the release of 8 MMcf of natural gas in one day during the development, production, or decommissioning phase due to development plan activities. Most gas escaping and contacting water would dissipate quickly, likely resulting in no large-scale effects on marine mammals, although some marine mammals in the immediate vicinity of a large natural gas release could be exposed to toxins and die before the gas could volatize. A gas release is expected to have negligible to minor effects on marine mammals.

Oil-spill Risk Analysis (OSRA)

Marine mammals represented in the OSRA model are listed in Tables A.1-8 through A.1-10 of Appendix A, respectively. A summary of the highest percent chance that a large oil spill will contact resources for marine mammals within 3 and 30 days during summer and winter is provided in Tables 4.3.2-15 through 4.3.2-17, respectively (based on conditional probabilities, assuming a large spill occurs). It is important to note that ERAs represent areas of social, economic, or biologic importance designated by BOEM analysts in the Alaska OCS region (see Appendix A). ERAs are assigned to species for which there is sufficient information to confidently identify the area as important to that species, usually during specific seasons. Other species or groups may be present in ERAs and affected by an oil spill. In this analysis, a large oil spill with ≤5% chance of contacting resources would likely be widely dispersed and weathered, and not estimated to produce appreciable impacts on marine mammals based on the spill assumptions in Appendix A, Section A-3.2, and thus will not be discussed in detail here. In addition the conditional probability tables in Appendix A assume a large spill occurs and reflect the percent chance of a large spill contacting any portion of a LS, GLS or ERA. In this context, contact does not necessarily imply the entire area (especially for large ERAs) or all resources in the area would be affected by a large spill.

Table 4.3.2-15. Highest Percent Chance of a Large Oil Spill Contacting Whale Resources[1]

OSRA Feature Type	Highest Chance of Contact	Summer		Winter	
		3 days	30 days2	3 days	30 days2
Environmental Resource Area (ERA)	≥0.5–<6	16, 70, 77, 82, 94, 95, 98	70, 73, 78, 84, 85, 86, 87, 89, 91, 92, 97, 99, 109	16, 24, 70, 77, 94, 95	16, 26, 27, 70, 76, 78, 89, 91, 94, 97, 99, 109
	≥6–<25	80, 81, 90, 101	16, 76, 77, 81, 82, 83, 94, 95, 98, 101, 108	75, 80, 90	24, 25, 75, 77, 95, 98, 108
	≥25–<50	71, 72, 75, 102, 103, 105	71, 75, 80, 90, 102, 103, 105	71	71, 80, 90
	≥50	104	72, 104	72	72

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5% are shown.
[2] Note that the highest percent chance of contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.
Data derived from Appendix A (Tables A.1-8, A.2-22, A.2-24, A.2-42, and A.2-44). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

Table 4.3.2-16. Highest Percent Chance of a Large Oil Spill Contacting Seal and Sea Lion Resources[1]

OSRA Feature Type	Highest Chance of Contact	Summer		Winter	
		3 days	30 days[2]	3 days	30 days[2]
Environmental Resource Area (ERA)	≥0.5–<6	16, 21, 23, 24, 37	21, 27, 28, 29, 30, 31, 32, 37, 38, 43	16, 20, 24, 37	16, 20, 26, 27, 28, 29, 30, 31, 37, 43
	≥6–<25	19, 20	16, 19, 20, 23, 24, 25, 26	19, 23	19, 23, 24, 25
	≥25–50	15, 18	15, 18	15, 17, 18	15, 17, 18
	≥50	11, 12, 13, 14, 17	11, 12, 13, 14, 17	11, 12, 13, 14	11, 12, 13, 14

Notes: [1] Highest percent chance from any launch are (LA) or pipeline area (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5% are shown.
[2] Note that the highest percent chance of contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.
Data derived from Appendix A (Tables A.1-9, A.2-22, A.2-24, A.2-42, and A.2-44). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

Table 4.3.2-17. Highest Percent Chance of a Large Oil Spill Contacting Sea Otter Resources[1]

OSRA Feature Type	Highest Chance of Contact	Summer		Winter	
		3 days	30 days[2]	3 days	30 days[2]
Environmental Resource Area (ERA)	≥0.5–<6	16, 49, 68	50, 51, 59, 60, 65, 66	16, 49	50, 57, 59, 60, 65
	≥6–<25	45	45, 49, 64, 67, 68,	68	49, 64, 67, 68
	≥25–<50	48	--	45, 46	45, 46
	≥50	46, 47	46, 47, 48	47, 48	47, 48
Land Segment (LS)	≥0.5–<6	--	84, 86, 87	--	84, 86, 87
	≥6–<25	35	35	35	35
Grouped Land Segment (GLS)	≥0.5–<6	152	124, 152, 159	152	124, 152, 159
	≥6–<25	141	141	141	141

Notes: -- all percent chances of contact are <0.5%.
[1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5% are shown.
Note that the highest percent chance of contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.
Source: Appendix A (Tables A.1-10, A.2-22, A.2-24, A.2-27, A.2-29, A.2-32, A.2-34, A.2-42, A.2-44, A.2-47, A.2-49, A.2-52, and A.2-54). Maps of ERAs, LSs, and GLSs are provided in Appendix A**,** Maps A-2a through A-4b.

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. The relatively low percent chance of one or more large spills occurring and contacting various environmental resources is illustrated by examination of the highest combined probabilities. As shown in Appendix A, Table A.2-61, for many ERAs, the highest combined probabilities within 30 days range from 1% to 14% for the west side of Cook Inlet. The ERAs with combined probability of 10% or greater of one or more large spills occurring and contacting them within 3 or 30 days include:

- 13–14% – ERA 12, South Cook HS 1a (harbor seals)
- 9–12% – ERA 13, South Cook HS 1b (harbor seals)
- 8–11% – ERA 47, SW Cook Inlet (sea otters)
- 7–12% – ERA 72, West Cook Inlet – Beluga Critical Habitat (Cook Inlet beluga whales)
- 9–10% – ERA 145, Outer Kachemak Bay/IBA (sea otters)

All other ERAs had combined probabilities of <10%. Combined probabilities for GLSs deemed important for sea otters were ≤2% and will not be discussed in detail here.

Spill Response activities

Cleanup operations following a large oil spill would be expected to involve multiple marine vessels operating in the spill area for extended periods of time, perhaps over multiple years. Based on information provided in the discussion of impacts associated with vessel traffic, marine mammals react to the approach of vessels at greater distances than they react to most other industrial activities. According to Richardson and Malme (1993), whales rapidly swam 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, though a few whales may react at distances from 5-7 km (3-4 mi).

After a large spill, there are typically overflights using helicopters and fixed-winged aircraft to track the spill and to determine distributions of wildlife that may be at risk from the spill. Most marine mammals are unlikely to react markedly to occasional single passes by helicopters flying at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some marine mammals would probably 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). Whale reactions to a single helicopter flying overhead probably are temporary (Richardson et al., 1995), and most marine mammals should resume their normal activities within minutes after aircraft pass. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) sometimes caused abrupt turns and hasty dives (Richardson and Malme, 1993). The effects from an encounter with aircraft are brief, and whales should resume their normal activities within minutes.

Likewise other cleanup activities such as burning, mechanical recovery of spilled materials, or the use of dispersants could have varying effects on marine mammals based on oceanographic conditions, weather, spill size, etc. The use of dispersants could have deleterious effects on lower trophic level species, particularly those in the benthic environment. With dispersants, the effects would depend on the chemical composition of the dispersants and the quantities of dispersant used. On the other hand, burning spilled hydrocarbons is another commonly used technique for removing spilled materials from the ocean surface, with varying degrees of success. Both burning and mechanical cleanups with the accompanying amount of work activity mostly discourage marine mammal presence in the local area.

Based on all of the above information, marine mammals could potentially be displaced from a feeding area after a large spill and this displacement could last as long as there is a large amount of oil and related clean-up vessels present.

Cetaceans

The OSRA model estimates the percent chance of a large spill contacting specific cetacean ERAs (summarized in Table 4.3.2-14) and is analyzed in terms of the cetaceans associated with those ERAs (defined in Appendix A, Table A.1-8). The potential effects of oil spills on each cetacean species are also discussed in this section using the OSRA model estimates for 3 or 30 days, summer or winter, from any LA or PL, called conditional probabilities.

Cook Inlet Beluga Whale

The OSRA model estimates the percent chance of a large spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to beluga whale ERAs (16 and 69 to 72) in Cook Inlet and the surrounding region is as follows (with references to relevant maps in Appendix A):

- ≥50% – ERA 72, West Cook Inlet Beluga Critical Habitat (Map A-2b)
- ≥25% to <50% – ERA 71, Middle Cook Inlet Beluga Critical Habitat (Map A-2b)

- ≥6% to <25% – ERA 16, Inner Kachemak Bay (Map A-2b)
- ≥0.5% to <6% – ERA 70, Forelands Beluga Critical Habitat (Map A-2a)

The OSRA model estimates ERA 69 (Upper Cook Inlet Beluga Critical Habitat, Map A-2a) has a <0.5% chance of contact. Cook Inlet beluga whales are vulnerable in these ERAs year-round (Hobbs et al., 2005) (Appendix A, Table A.1-8). ERAs 70, 71, and 72 occur in Cook Inlet Beluga Whale Critical Habitat Area 2, an area designated as important for fall and winter feeding and transit (76 *FR* 20180, April 11, 2011). ERA 72 is in the far southern extent of the Cook Inlet beluga whale range, and has the highest percent chance of contact (≥50%). Beluga whales would be less likely to be in ERA 72 in the summer months in any great numbers; however, this area has been determined to be an important fall and winter feeding and transit area (Hobbs et al., 2005). ERAs 71 and 70 occur in mid-Cook Inlet, an area that beluga whales are known to use throughout the year, although they generally concentrate in upper Cook Inlet in the summer (Ashford, Ezer and Jones, 2013; Hobbs et al., 2005). Additionally, these ERAs occur in areas considered to be year-round small and resident population biologically important areas (BIAs) for beluga whales (Ferguson, Curtis, and Harrison, 2015). Combined probabilities for ERA 71 are 5% and for ERA 72 are 7% and 12% within 3 and 30 days, respectively (Appendix A, Table A.2-61).

Killer Whale

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to killer whale ERAs (24 to 28, 30, 89 to 91) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥6% to <25% – ERA 108, Shelikof Killer Whale (Map A-2e)
- ≥0.5% to <6% – ERA 109, East Kodiak Killer Whale (Map A-2e)

Killer whales are deemed vulnerable in these areas year-round. ERAs 108 and 109 are located around Kodiak Island, an area commonly used by killer whale stocks in the region, notably in summer months, but they have been observed year-round (Zerbini et al., 2007). ERA 41 (Resurrection/Chiswell; Map A-2c) also is important habitat for killer whales (Matkin et al., 2012) but is not estimated to be contacted. The OSRA model estimates the combined probability for ERA 108 is <0.5% and 2% within 3 and 30 days, respectively and ERAs 41 and 108 have a <0.5% combined probability.

Fin Whale

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to fin whale ERAs (24 to 28, 30, 89 to 91) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥25% to <50% – ERA 90, Barren Islands (Map A-2f)
- ≥6% to <25% – ERA 24 and 25, Shelikof MM2–3 (Map A-2d)
- ≥0.5% to <6%) – ERA 26–28, 30, Shelikof MM4–6, 8 (Map A-2d); ERA 89, Shelikof MM11 (Map A-2h); ERA 91, NE Kodiak Fin Whale (Map A-2f)

ERA 30 (Shelikof MM 8; Map A-2d) is not estimated to be contacted within 30 days. The OSRA model estimates the combined probabilities for these ERAs range from <0.5-1% and <0.5-4% within 3 and 30 days respectively. These ERAs occur around southern Kodiak Island and the Shelikof Strait, areas deemed feeding BIAs for fin whales (Ferguson, Curtis, and Harrison, 2015). The highest densities of fin whales in this area occur from June through August, although they have been observed in the area year-round by aerial and acoustic surveys (Clapham et al., 2012; Moore et al., 2006; Stafford et al., 2007; Witteveen, pers. comm., 12 January 2015 cited in Ferguson, Curtis, and Harrison, 2015) and deemed vulnerable.

Gray Whale

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to gray whale ERAs (92 to 99) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥6% to <25% – ERA 94, Lower E Kenai Gray Whale (Map A-2c); ERA 95, NE Kodiak Gray Whale (Map A-2g); and ERA 98, Shelikof Gray Whale (Map A-2g)
- ≥0.5% to <6% – ERA 92, Kodiak Gray Whale Feeding (Map A-2g); ERA 97, SE Kodiak Gray Whale (Map A-2f); ERA 99, N Shumagin Gray Whale (Map A-2h)

ERAs 93, 96, and 100 are not estimated to be contacted. Gray whales are deemed vulnerable in ERAs 93 to 99 from April to December, in ERA 92 from June to August, and in ERA 100 from October to December (Appendix A, Table A.1-8). The OSRA model estimates the combined probabilities for these ERAs are <0.5% and <0.5-1% within 3 and 30 days respectively. All of these ERAs occur around Kodiak Island and adjacent to the Alaska Peninsula, areas deemed migratory BIAs for gray whales (Ferguson, Curtis, and Harrison, 2015). As the highest densities of gray whales in this migratory BIA occur from November to January when whales are southbound and from March to May when whales are northbound (Braham, 1984a,b; Rugh, 1984; Rugh, Shelden, and Schulman-Janiger, 2001), gray whales would have a higher risk of exposure to oil if a large oil spill occurred during these times. Additionally, ERAs 95 and 98 occur in gray whale feeding BIAs (Ferguson, Curtis, and Harrison, 2015). The greatest densities of whales in this BIA are from June to August (Moore et al., 2007; Witteveen, pers. comm., 12 January 2015, as cited in Ferguson, Curtis, and Harrison, 2015; Wynne and Witteveen, 2005, 2013), and gray whales would be at increased risk of exposure to oil during this time.

Humpback Whale

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to humpback whale ERAs (75 to 79) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥25% to <50% – ERA 75, Kachemak Humpback Whale (Map A-2c)
- ≥6% to <25% – ERA 76, Shelikof Humpback Whale (Map A-2f); ERA 77, North Kodiak Humpback Whale (Map A-2c)
- ≥0.5% to <6%) – ERA 78, E Kodiak Humpback Whale (Map A-2f)

ERA 79 (South Kodiak Humpback Whale; Map A-2f) is not estimated to be contacted. Humpback whales are deemed vulnerable in these areas from May to December. ERAs 76 to 78 occur around the Kodiak Island in a feeding BIA for humpback whales (Ferguson, Curtis, and Harrison, 2015). The OSRA model estimates the combined probabilities for these ERAs range from <0.5-1% and <0.5-3% within 3 and 30 days respectively. The highest densities of humpback whales in this BIA occur from July through September (Witteveen et al., 2007, 2011). ERA 75 (Kachemak) occurs just north of the BIA, on the southern extent of the Kenai Peninsula, another area of high use by humpback whales in the summer (Witteveen et al., 2011). Humpback whales would be most immediately impacted in these areas from a large spill in the summer and fall (Witteveen, pers. comm., 12 January 2015, as cited in Ferguson, Curtis, and Harrison, 2015, although there may be additional impacts from long-term oil exposure in the areas from contaminated environment and prey species.

North Pacific Right Whale

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to North Pacific right whale ERAs (73 to 74) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥0.5% to <6% – ERA 73, NPRW Feeding Area (in summer only) (Map A-2f)

The OSRA model estimates ERA 74 (NPRW Critical Habitat; Map A-2d) has a <0.5% chance of contact. The OSRA model estimates the combined probabilities for these ERAs are <0.5% within 3 and 30 days. North Pacific right whales are considered vulnerable in these areas from June to September (Appendix A, Table A.1-8). ERA 73 occurs along the eastern extent of Kodiak Island, area feeding BIA for North Pacific right whales (Ferguson, Curtis, and Harrison, 2015). The highest densities of these whales in this area occur from June through September (Ivashchenko and Clapham, 2012; Mellinger et al., 2004; Wade et al., 2011a; Waite, Wynne, and Mellinger, 2003), with few if any data available from other months.

Harbor Porpoise

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to harbor porpoise ERAs (101 to 107) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥50% – ERA 104, Cook Inlet 4 Harbor Porpoise (in summer only) (Map A-2c)
- ≥25% to <50% – ERA 102, Cook Inlet 2 (Map A-2a); ERA 103, Cook Inlet 3 (Map A-2c); and ERA 105, Cook Inlet 5 (Map A-2b) (all in summer only)
- ≥6% to <25% – ERA 101, Cook Inlet 1 (in summer only) (Map A-2a)

Harbor porpoise ERAs 106 (SE Kodiak) and 107 (S Kodiak) have a <0.5% chance of contact. There are no harbor porpoise ERAs estimated to be contacted by a spill starting in winter months. The OSRA model estimates the combined probabilities for these ERAs range from <0.5-4% and <0.5-5% within 3 and 30 days respectively. Harbor porpoises are listed as vulnerable in these areas from June to December (Appendix A, Table A.1-8) but may be present year-round (Shelden et al., 2014).

Dall's Porpoise

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to Dall's porpoise ERAs (81 to 88) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥6% to <25% – ERAs 81 to 83, Cook Inlet MM1a to 3a (Map A-2d) (in summer only)
- ≥0.5% to <6% – ERA 82, Shelikof MM 2a (Map A-2d); ERAs 84 to 87, Shelikof MM 4a, 5a, 6a, 9 (all in summer only) (Map A-2d)

During the winter season there is a <0.5% chance of contact to any Dall's porpoise ERA, and ERA 88 (Shelikof MM 10; Map A-2h) is not estimated to be contacted in either season. The OSRA model estimates the combined probabilities for these ERAs are <0.5% and <0.5-1% within 3 and 30 days, respectively. Dall's porpoise are deemed vulnerable in these areas from June to August (Appendix A, Table A.1-8). Concentrations of Dall's porpoise have been reported in Shelikof Strait and around Kodiak and Afognak Islands (USDOI, MMS, 2003).

Other Whales

Specific ERAs were not assigned for sperm whales, sei whales, blue whales, minke whales, Pacific white-sided dolphins, and the three beaked whales (Cuvier's, Baird's, Stejneger's), because there currently is not sufficient information for these species in the OSRA area to confidently delineate ERAs for them. However, the impacts from spills on these species are discussed in their respective sections later in this chapter.

Pinnipeds

The percent chance of contact to specific pinniped ERAs (summarized in Table 4.3.2-16) are analyzed in terms of the pinnipeds associated with those ERAs (defined in Appendix A, Table A.1-9). The potential effects of oil spills on each pinniped species are also discussed in this section.

Harbor Seal

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to one of the 33 harbor seal ERAs (11 to 44) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥50% – ERA 11, Augustine; ERAs 12 and 13, South Cook HS 1a to c; ERA 17, Clam Gulch HS (in summer only) (all shown on Map A-2a)
- ≥25% to <50% – ERA 15, South Cook HS 1d; ERA 18, Tuxedni HS; ERA 17, Clam Gulch HS (in winter only) (all shown on Map A-2a)
- ≥6% to <25% – ERA 16, Inner Kachemak Bay (in summer only) (Map A-2b); ERA 19, Kalgin Island HS (Map A-2a); ERA 20, Redoubt Bay HS (in summer only) (Map A-2b); ERA 23, Barren Islands Pinnipeds (Map A-2b); ERAs 24 and 25, Shelikof MM2 and3 (Map A-2d); ERA 26, Shelikof MM4 (in summer only) (Map A-2d); and
- ≥0.5% to <6% – All other harbor seal ERAs (see Table 4.3.2-16)

The OSRA model estimates the combined probabilities for these ERAs range from <0.5-13% and 1-14% within 3 and 30 days, respectively. Harbor seals are listed as vulnerable year-round in ERAs 11 to 17 and 23 to 44, and in ERAs 18 to 22 from March to December (Appendix A, Table A.1-9). Harbor seals are regularly seen throughout Cook Inlet, especially during spring eulachon and summer salmon runs (Nemeth et al., 2007). Potentially affected stocks in Cook Inlet (Cook Inlet/Shelikof and North and South Kodiak stocks) are generally considered non-migratory and show strong site fidelity for haul-out during the breeding season (Pitcher and McAllister, 1981; Small et al., 2005). Important harbor seal haul-out areas occur within Kamishak and Kachemak Bays and along the coast of the Kodiak Archipelago and the Alaska Peninsula. Chinitna Bay, Clearwater and Chinitna Creeks, Tuxedni Bay, Kamishak Bay, Oil Bay, Pomeroy and Iniskin Islands, and Augustine Island are also an important spring-summer breeding and molting areas as well as known haul-out sites (Boveng, London, and Ver Hoef, 2012). The ERAs discussed earlier occur in the southern extent of Cook Inlet throughout important harbor seal haul-out areas; the highest percent chance ERAs occur on the southwestern side (in and near Kamishak Bay), and with relatively lower percent chance of contact to ERAs on the southeastern side (near the southern extent of the Kenai Peninsula).

Steller Sea Lion

The OSRA model estimates the percent chance of a large oil spill contacting within 3 or 30 days (whichever occurs first) in summer or winter to one of the 21 Steller sea lion ERAs (23 to 44) in Cook Inlet and the surrounding region is as follows (with references to relevant maps and tables in Appendix A):

- ≥6% to <25% – ERA 23, Barren Islands Pinnipeds (Map A-2b); ERAs 24 and 25, Shelikof MM2 and 3 (Map A-2d); ERA 26, Shelikof MM4 (in summer only) (Map A-2d)
- ≥0.5% to <6% – All other Steller sea lion ERAs (see Table 4.3.2-16)

The OSRA model estimates the combined probabilities for these ERAs are <0.5% and 1-3% within 3 and 30 days, respectively. Steller sea lions are listed as vulnerable year-round in these ERAs (Appendix A, Table A.1-9). All of these ERAs occur within the western DPS Steller sea lion critical habitat (58 *FR* 45269, August 27, 1993), so designated because the area contains important habitat features such rookeries (e.g., ERA 31 and 23), major haul-outs (and their surrounding aquatic zones), and aquatic foraging areas (e.g., ERAs 24 to 26).

Fur Seal

Because the main habitat range of fur seals occurs outside of the proposed Lease Sale Area in the Gulf of Alaska (Consiglieri et al., 1982; Loughlin et al., 1999; Merrick, Loughlin, and Calkins, 1987), their exposure to oil would likely be limited to the oil that reaches the gulf from the origin point in Cook Inlet. Although ERAs are not identified specifically for fur seals, they are known to use some of the same areas as the WDPS of Steller sea lions. Most of the ERAs occur near Kodiak Island and Shelikof Strait. Fur seals may be particularly prone to oil exposure in these areas during their seasonal migration through the Gulf of Alaska in April through June and October; however, they may be found throughout their range at any time of the year. The northward migration of individuals wintering in southern parts of the range begins in March, and from April to mid-June, large numbers are found in Gulf of Alaska coastal waters (Consiglieri et al., 1982). By April, the seal migration reaches the vicinity of Kodiak Island and during the summer months, after adult females and males have migrated through the Aleutian Islands and into the Bering Sea, the majority of fur seals remaining around Kodiak Island are non-breeding individuals. Southward migration from the Pribilof Islands begins in October; by December, seals appear off southeast Alaska (USDOI, MMS, 2003).

Fissipeds (*Sea Otters*)

Because sea otters use both land and water features, ERAs, LSs, and GLSs were used in the OSRA model to estimate potential contact with spilled oil in their habitat range (Table 4.3.2-17; Appendix A, Table A.1-10). The effects of oil spills on sea otters are discussed later in this chapter.

The estimated percent chance of contact of a large oil spill within 3 or 30 days (whichever occurs first) in summer or winter to one of the 26 sea otter ERAs in Cook Inlet and the surrounding region (ERAs 16, 45 to 68, and 145) is as follows (with references to relevant maps in Appendix A):

- ≥50% – ERA 46, Outer Kachemak Bay (summer only); ERA 47, SW Cook Inlet; ERA 48, Kamishak Bay (all shown in Map A-2b)
- ≥25% to <50% – ERA 45, Clam Gulch (winter only) (Map A-2a); ERA 46, Outer Kachemak Bay (winter only) (Map A-2b)
- ≥6% to <25% – ERA 16, Inner Kachemak Bay (in summer only) (Map A-2b); ERA 45, Clam Gulch (in summer only) (Map A-2a); ERA 49, Katmai National Park (Map A-2e); ERA 64, Afognak West (Map A-2e); ERA 67, Shuyak (Map A-2e); ERA 68, Kenai Fjords West (Map A-2b)
- ≥0.5% to <6%) – All other sea otter ERAs (see Table 4.3.2-17)

Sea otters are vulnerable year-round in these ERAs (Appendix A, Table A.1-10). Eleven of the ERAs (ERAs 47 to 49, 50, 51, 57, 59, 60, 64, 66, and 67) occur within northern sea otter critical habitat. The three ERAs with the highest percent chance of contact (≥50%) Kachemak Bay (ERA 46), Kamishak Bay (ERA 48), and along the southwestern coast of Cook Inlet (ERA 47) are areas with abundant numbers of sea otters (Bodkin, Monson, and Esslinger, 2003; Gill, Doroff, and Burn, 2009).

The estimated percent chance of contact of a large oil spill within 3 or 30 days (whichever occurs first) in summer or winter to one of the seven sea otter LSs in Cook Inlet and the surrounding region (LSs 7, 15, 35, 65, 84, 86, 87, and 92) is as follows (with references to relevant maps in Appendix A):

- ≥6% to <25% – LS 35, Tuxedni Bay (Map A-3c)
- ≥0.5% to <6% – LS 84, Raspberry Strait (Map A-3b); LS 86, Uginak Bay/Passage (Map A-3b); LS 87, Uyak Bay (Map A-3b)

All other sea otter LSs in Appendix A, Table A.1-10, are not estimated to be contacted. Sea otters are vulnerable year-round in these LSs. LS 35 is adjacent to Tuxedni Bay, designated sea otter critical habitat. LSs 84, 86, and 87 are on the eastern side of Kodiak Island, also adjacent to sea otter critical habitat.

The estimated percent chance of contact of a large oil spill within 3 or 30 days (whichever occurs first) in summer or winter to one of the nine sea otter GLSs in Cook Inlet and the surrounding region (GLSs 119, 124, 141, 144, 146, 149, 150, 152, and 159) is as follows (with references to relevant maps in Appendix A):

- ≥6% to <25% – GLS 141, Seldovia side Kachemak Bay (Map A-4b)
- ≥0.5% to <6%) – GLS 124, Kukak Bay (Map A-4b); GLS 152, Barren Islands (Map A-4a); GLS 159, Kupreanof Strait (Map A-4a)

All other sea otter LSs in Appendix A, Table A.1-10, are not estimated to be contacted. GLS 124 is along Kukak Bay on the eastern side of the Alaska Peninsula, and GLS 152 is in the Barren Islands; both are adjacent to sea otter critical habitat. The OSRA model estimates the combined probabilities for these ERAs, LSs or GLSs range from <0.5-8% and 1-11% within 3 and 30 days, respectively.

Oil Spill Response

Potential mitigating factors such as spill response strategies are generally described in Section 4.2.14.3. However, these mitigating factors are not considered in the spill impact analysis.

4.3.6.9. Potential Impacts by Species

General impacts to marine mammals from IPFs were previously described in Sections 4.3.6.1 through 4.3.6.8. Species-specific information is not available for every IPF that may affect each species. This section describes species-specific information for IPFs only where published literature is available to support information regarding impacts from that IPF; for species where IPFs are excluded here, the reader is referred to the general description of impacts from IPFs in Sections 4.3.6.1 through 4.3.6.8.

The level of effects to marine mammals from the Proposed Action will likely be eliminated or greatly reduced by the application of mitigation measures typically required by NMFS and the USFWS under the MMPA and ESA. Previous mitigations for oil and gas activities have included the presence of PSOs on board industry vessels to detect and avoid marine mammals, shutdown and ramp up procedures for seismic and other equipment use, protocols for vessels and aircraft to avoid marine mammals, monitoring, and operational modifications intended to reduce or eliminate disturbance to marine mammals. The expected suite of mitigation measures (as described in Section 2.6) were specifically developed by NMFS and the USFWS to prevent incidents of Level A harassment and reduce Level B harassment. It is reasonable to assume that such mitigations will continue to be applied to operators throughout the duration of the Proposed Action; however, the impact rating resulting from the analysis of IPFs does not take into account the typical mitigation measures generally expected from other agencies (e.g., USFWS and NMFS).

For marine mammal species that are uncommon in the proposed Lease Sale Area but have habitat ranges that overlap with the OSRA extent as described in Section 4.3.6 (NOAA, 2015b; Appendix A, Map A-1), only the potential effects of large oil spills are analyzed. These species will likely not be impacted by the other IPFs identified in Section 4.2 because there is no, or extremely limited, potential for any spatial overlap to occur.

Cetaceans

Cook Inlet Beluga Whale (*Delphinapterus leucas*) (Endangered)

In contrast to most beluga whale populations worldwide, which are observed seasonally in estuarine habitats, Cook Inlet beluga whales reside in Cook Inlet year-round (NMFS, 2008c).

Seafloor Disturbance and Habitat Alteration

Oil and gas activities can result in substantial changes in habitat, including temporary or permanent loss of habitat, which may reduce the amount or types of prey available to Cook Inlet beluga whales (NMFS, 2015a). Such activities include in-water construction, dredging, and other oil and gas activities previously described in Section 4.2.1. These activities may cause avoidance or destruction of an area used by beluga whale prey as a result of oil and gas activities (NMFS, 2015a). In addition to loss of habitat available to beluga whale prey species by displacement or avoidance, oil and gas activities may reduce the quality of the prey as a result of contamination of the habitat. For example, mechanical disturbance of the seafloor (e.g., dredging) re-suspends silt, and any buried chemicals, into the water column. Reduction in the amount or types of prey available to Cook Inlet beluga whales may reduce their fitness or lead to mortality (Burek-Huntington et al., 2015). However, as described in Section 4.3.2.5, the area affected over time is too limited to have measurable adverse effects to Cook Inlet beluga whale prey items of fish and shellfish. Consequently seafloor disturbance and habitat alteration should have negligible effects on beluga whales.

Noise

Noise from oil and gas activities may have adverse impacts on Cook Inlet beluga whales (Erbe and Farmer, 2000; NMFS, 2015a). Studies on beluga whales have revealed that anthropogenic noises could cause threshold shifts in beluga whale hearing capabilities (Finneran et al., 2000, 2002a; Schlundt et al., 2000); could mask the ability of animals to hear and decipher specific sounds (Erbe and Farmer, 2000; Erbe et al., 1999); could result in beluga whales altering their vocal behaviors (Lesage et al., 1999; Scheifele et al., 2005); or could result in displacement of animals from habitats (Finley, 1990; Harris, Elliott, and Davis, 2007; Richardson and Würsig, 1997). Beluga whales are categorized as mid-frequency cetaceans with functional hearing in the 50 Hz to 200 kHz range (Table 4.3.2-11) (Ciminello et al., 2012; Finneran and Jenkins, 2012; Southall et al., 2007).

The draft Cook Inlet Beluga Recovery plan lists noise as a potential threat to the species with a “high” relative concern, with effects including compromised communication and echolocation, physiological damage, and habitat degradation (NMFS, 2015a). NMFS categorizes anthropogenic sources by order of importance based on signal characteristics and the spatiotemporal footprint (NMFS, 2015a). The order was determined by considering the following factors: intensity, frequency, duration of acoustic signal, area affected by the sound source, duration of sounds in both seasonal terms, and frequency of occurrence (M. Castellote, NMFS, unpub. data, as cited in NMFS, 2015a).

There are documented spatial displacements of beluga whales caused by loud sources of noise. One seismic survey in the Canadian Beaufort Sea determined behavioral reactions of beluga whales occurred when two 24-airgun arrays of 2,250 in^3 capacity were operating (Miller et al., 2005). Results of the analysis of the differences between vessel- and aerial-based beluga whale sighting distributions provided evidence of reactions of beluga whales to seismic operations at distances >20 km (12.4 mi), beyond the effective visual range of the MMOs on the seismic vessel (Miller et al., 2005).

Seismic surveys would occur within the first 3 years of the Proposed Action. Research indicates beluga whales could be displaced by seismic noise (Erbe and Farmer, 2000), which could result in increased energetic losses, possibly leading to reduced fitness. Beluga whales, if present in the vicinity of survey activities, will likely avoid the area unless they are engaged in feeding or social activity. Noise produced by seismic airgun arrays, sonar, and vessel traffic would be audible to beluga whales. Data suggest beluga whales may be more responsive to airgun noise (primary amplitude frequency range 5 to 300 Hz) than might be expected considering their relatively poor low-frequency hearing (Southall et al. 2007). Reactions at longer distances may be particularly likely when sound propagation conditions are conducive to transmission of the higher-frequency components of airgun sound to the animals’ location (DeRuiter et al., 2006; Goold and Coates, 2006; Potter et al., 2007; Tyack et al., 2006). Seismic surveys will likely have negligible effects on beluga whales in the summer months as most belugas concentrate in upper Cook Inlet (outside of the proposed Lease Sale Area), and minor to moderate effects during fall/winter months without the typical mitigation measures such as PSOs, ramping up/down, and shutdowns in the presence of beluga whales, are implemented. With NMFS imposed mitigations (e.g., avoidance, shutdown, startup), the level of effects would be reduced but remain negligible for belugas.

Noise associated with well drilling, and accompanying small and large support vessel noises is expected in years 2 to 5 of the Proposed Action and may produce negligible to minor effects on beluga whales, including TTS, displacement/avoidance, and masking, but only if a beluga were to enter the area where the water was ensonified to 160-190 or ≥190 dB meeting the NMFS criteria for TTS and PTS. Beluga whales have been shown to have greater displacement in response to a moving sound source (e.g., airgun activity on a moving vessel) and less displacement or behavioral change in response to a stationary sound source (NMFS, 2015b). Sheifele et al. (2005) studied a population of beluga whales in the Saint Lawrence Estuary to determine whether beluga whale vocalizations showed intensity changes in response to shipping noise. This type of behavior has been observed in humans and is known as the Lombard vocal response (Lombard, 1911). Sheifele et al. (2005) demonstrated that shipping noise did cause beluga whales to vocalize louder. The acoustic behavior of this same population of beluga whales was studied in the presence of ferry and small boat noise. Lesage et al. (1999) described more persistent vocal responses when whales were exposed to the ferry than to the small boat noise. These included a progressive reduction in calling rate while vessels were approaching, an increase in the repetition of specific calls, and a shift to higher frequency bands used by vocalizing animals when vessels were close to the whales. Lesage et al. (1999) concluded these changes and the reduction in calling rate to almost silence may reduce communication efficiency, which is critical to a gregarious species. However, Lesage et al. (1999) also stated that because of the gregarious nature of beluga whales, this “would not pose a serious problem for intraherd communication” given the short distance between group members, and concluded a noise source would have to be very close to limit communication within the beluga whale group (Lesage et al., 1999).

When drilling sounds were played to beluga whales in industry-free areas, the whales showed a behavioral reaction only when received levels were high (Richardson and Würsig, 1997). Beluga whales have been observed to show startle responses when drilling noises were played with a received level ≥153 dB re 1 µPa @ 1 m (Richardson and Würsig, 1997). Lastly, during drilling at the Cosmopolitan Unit in Lower Cook Inlet, belugas were regularly observed approaching to within 100-150 m of artificial islands engaged in drilling, 1 km of operational drillship (Richardson, 1995).

Pile driving is a technique used to fix production platforms to the seafloor in the proposed Lease Sale Area. Pile driving is a continuous noise source expected to produce SPLs up to 250 dB re 1 µPa and emit frequencies in the 100 to 500 Hz range, frequencies that are audible to beluga whales. Although the 250 dB re 1 µPa SPL is well above the Level A (180 dB re 1 µPa) and Level B (120 dB re 1 µPa) harassment thresholds used by NMFS, the impacts to beluga whales are likely minor as the noise levels are expected to drop considerably in a relatively short distance from the source (Blackwell, 2005; Greene and Moore, 1995) and beluga whales are likely to detect and avoid these activities.

Other construction noises during development may include dredging and pipeline installation. 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 (15.5 mi) in nearshore areas.

In past surveys, the interactions of beluga whales and dredge noise were observed; beluga whales showed greater reactions to large ships. Moreover, bowhead whales did not modify their behavior in areas where actual dredging occurred, suggesting some level of habituation to dredge noise may develop among cetaceans (Richardson et al., 1995).

Richardson (1995) summarized information relating to platform construction noises, and concluded 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.

Impacts from noise associated with the decommissioning phase stem from equipment and vessel noises, which have already been discussed.

Given that most Cook Inlet beluga whales spend the ice-free months in the upper portion of Cook Inlet (Hobbs et al., 2005) to the north of the proposed Lease Sale Area, noise impacts to beluga whales are estimated to be minor during summer months. As Cook Inlet beluga whales move south into the mid-inlet during fall and winter months (Hobbs et al., 2005), they have a higher likelihood of adverse impacts from noise associated with the Proposed Action compared to the summer. Because beluga whales in other areas have demonstrated a 20 km (12.4 mi) avoidance of seismic surveys, the otherwise small area of avoidance with other oil and gas activities, and the general absence of belugas from lower Cook Inlet during summer, the effects of noise on beluga whales is expected to be negligible to minor. If the Cook Inlet beluga stock ever recovers, some whales might remain in lower Cook Inlet during summer and may be displaced from preferred habitat, such as important feeding and traveling areas, which could potentially have adverse effects on the health and fitness of a few individual beluga whales.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have negligible effects on beluga whales. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a, 1985b). NMFS typically requires a 1,000 ft (305 m.) minimum altitude for aircraft operating in Cook Inlet, Alaska, which would further reduce the effects of aircraft traffic and noise on beluga whales.

Vessel Traffic

Local effects on the behavior, movement patterns, or habitat use of Cook Inlet beluga whales could occur because of disturbance from vessel traffic associated with drilling, seismic exploration, and other oil and gas exploration, development, production, and decommissioning activities (USDOI, MMS, 2003). The increase in vessel traffic from proposed exploration activities is expected to occur between shore bases and the drill platform. Given high existing levels of vessel traffic in Cook Inlet from fishing and existing oil and gas infrastructure, especially during the summer and early autumn months when activity would be concentrated, it is unlikely that this level of increased activity from the Proposed Action would result in discernible disturbance of any beluga whales in areas where such vessel traffic was already occurring (USDOI, MMS, 2003). In some cases, beluga whales exhibited rapid swimming from ice-breaking vessels up to 80 km (49.7 mi) away, and showed changes in surfacing, breathing, diving, and group composition in the Canadian high Arctic where vessel traffic is rare (Finley, 1990). In other cases, beluga whales were more tolerant of vessels, but responded differentially to certain vessels and operating characteristics by reducing their calling rates (especially older animals) in the Saint Lawrence River where vessel traffic is common (Blane and Jaakson, 1994). In Bristol Bay, Alaska, beluga whales continued to feed when surrounded by fishing vessels and resisted dispersal even when purposefully harassed (Fish and Vania, 1971). Given the large number of vessels in Cook Inlet and the apparent habituation to vessels by Cook Inlet beluga whales and the other marine mammals that may occur in the area, vessel activity and noise from vessels are expected to have negligible to minor impacts to Cook Inlet beluga whales.

Brief, minor effects on the behavior, movement patterns, or habitat use of Cook Inlet beluga whales could occur because of disturbance from the presence of support vessels, drilling, seismic exploration, and other disturbance associated with oil and gas exploration and development (USDOI, MMS, 2003). In Cook Inlet, beluga whales exercise site fidelity, returning to estuary areas even after a disturbance (Moore, DeMaster, and Dayton, 2000), continuing to occupy Cook Inlet alongside oil and gas development, vessel and aircraft traffic, and dredging operations. Moore, DeMaster, and Dayton (2000) concluded beluga whales have likely habituated to offshore oil and gas activities in central Cook Inlet.

Accidental Oil Spills and Gas Releases

The Draft Cook Inlet Beluga Recovery Plan (NMFS, 2015a) categorized oil spills and natural gas blowouts as a "high" potential threat to the recovery of the population, with the effects being mortality, compromised health, reduced fitness, and reduced carrying capacity. Oil spills and natural gas blowouts may have detrimental effects on Cook Inlet beluga whales (NMFS, 2015a), and may also affect their prey through changes to spawning or migration patterns, direct mortality, or potential long-term sublethal impacts (Marty et al., 1997; Moles, Rice, and Norcross, 1994; Murphy et al., 1999).

The highest percent chance a large spill will contact beluga whale ERAs is described in Section 4.3.6.7. As the Cook Inlet beluga whale population is small and residential, any impact from direct or indirect effects from a large oil spill has the potential for population-level impacts.

Upon contact with spilled oil, beluga whales may experience inhalation, ingestion, and skin and conjunctive tissue irritation. 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 within Cook Inlet. 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.

While some contaminants are known to bioaccumulate and be passed up the food chain, they could also affect the survival, quality, and reproduction of prey species (NMFS, 2015a). Cook Inlet fish populations could be vulnerable to oil contamination, and spill associated decreases in local forage fish populations could create periods when prey might be unavailable. Impacts to the distribution and abundance of prey, if they should occur, would largely determine the seasonal distribution and habitat use by beluga whales.

Although Cook Inlet beluga whales currently have lower contaminant loads (including PAHs) than other populations (Becker et al., 2000; Wetzel, Pulster, and Reynolds, 2010), an increase in PAHs in the Cook Inlet environment from an accidental spill could cause some adverse effects. High levels of PAHs have been offered considered as a factor in illness and mortality among beluga whales in the Saint Lawrence Estuary (Martineau et al., 1994, 2002); however, though no definitive causal relationship has been accepted. Saint Lawrence Estuary beluga whales have shown a greater prevalence of cancer than any other cetacean group in the world (Martineau et al., 2002), and one particular PAH, benzo(a)pyrene, might be the contaminant responsible for the elevated prevalence of cancer in this beluga population (NMFS 2015).

Oil components or chemical oil dispersant-derived compounds could be consumed by beluga whales feeding on prey in contaminated areas. Ingestion of petroleum hydrocarbons by mammals can lead to subtle, progressive organ damage, or rapid death in some cases. Many PAHs 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, and ingestion can decrease nutrient absorption (St. Aubin, 1988). Decreased food absorption could be especially important in very young animals, those feeding seasonally, and those needing to develop large amounts of fat for survival.

A large oil spill could displace beluga whales from, or prevent or disrupt access to, affected habitat areas. The loss of nursing/calving habitats by female belugas with calves and juveniles could create additional stresses, both physical and psychological, that may reduce the fitness of some individual belugas over time. Some of the effects from displacement might not be easily recovered from, at the very least partially compromising the ability of the stock to recover. A 5,100 bbl large spill from a production platform, or a 1,700 bbl from a pipeline would have limited potential to affect Cook Inlet belugas due to the size of the spill, existing spill response plans and supporting infrastructure in Lower Cook Inlet, and the dispersion/weathering of the spill over hours or possibly days as the spill is released. In all likelihood an oil spill would be contained, partially recovered, and perhaps burned, such that it is unlikely any belugas would be contacted by the spilled materials. For these reasons small or large spills should have a negligible level of effects on Cook Inlet beluga whales.

Conclusion

Seafloor disturbance and habitat alteration, vessel and aircraft traffic, and accidental oil spills and gas releases would have a negligible level of effects on beluga whales, while noise would probably have a negligible to minor level of effects on belugas.

Killer Whale (*Orcinus orca*)

Most of the confirmed sightings of killer whales in Cook Inlet have been in lower Cook Inlet near Homer and Port Graham (Rugh et al., 2005; Shelden et al., 2003). The few whales that have been photographically identified in lower Cook Inlet belong to resident groups more commonly found in nearby Kenai Fjords and Prince William Sound (Shelden et al., 2003).

Seafloor Disturbance and Habitat Alteration

The effects of seafloor disturbance and habitat alteration on killer whales would be similar to, but less than those described for beluga whales. Consequently, the seafloor disturbance from the Proposed Action would have a negligible level of effects on killer whales.

Noise

Killer whales are in the same mid-frequency functional hearing group as beluga whales, relying on sonar and echolocation to feed and navigate. Consequently, their shared anatomical similarities suggest the effects analyses for beluga whales should also apply for killer whales. As killer whales are only occasionally observed in lower Cook Inlet (Rugh et al., 2005; Shelden et al., 2003), small numbers of them could potentially be exposed to underwater noise from the Proposed Action. The noise from the Proposed Action occur within the audible hearing range of killer whales, such that they would be capable of detecting and avoiding noises that could cause physiological harm, though from the potential exists to elicit a TTS and/or masking (Erbe, 2002;(Kruse, 1991; Williams, 1999). Still the noise radii for from different oil and gas activities shows limits to how far away an adverse effect could occur from the noise source. Often the noise levels from oil and gas operations would be insufficient to produce a TTS, much less a PTS, or masking’ however the loudest activities, such as seismic surveying, can produce hazardous noise levels within a few meters of a firing airgun array. Without mitigation, the effects of the Proposed Action would most likely be negligible to minor based on an assumed natural tendency of killer whales to avoid areas that are very noisy. The use of PSOs, shutdown, ramp-up, and avoidance protocols, long established by the NMFS, should ensure that the noise levels in the Proposed Action would have a negligible level of effects on Killer whales.

Aircraft Traffic

Killer whales observed in lower Cook Inlet belong to resident groups more commonly found in nearby Kenai Fjords and Prince William Sound (Shelden et al., 2003), areas with high vessel and aircraft traffic as well as other signs of anthropogenic presence, with few known affects to killer whales.

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have negligible effects on killer whales. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a, 1985b).). NMFS typically requires a 1,000 ft (305 m.) minimum altitude for aircraft operating in Cook Inlet, Alaska, which would further reduce the effects of aircraft traffic and noise on killer whales.

Vessel Traffic

Vessel traffic resulting from the Proposed Action is described in Section 4.2.9. It is difficult to distinguish many of the effects of the presence of vessel traffic from the effects of the noise of vessel traffic. Several studies have linked vessels with short-term behavioral changes in Northern and Southern resident killer whales (Foote, Osborne, and Hoelzel, 2004; Kriete, 2002; Kruse, 1991; Williams et al., 2002a, 2002b), although it is not clear if the effects are from the presence of the vessels themselves, the noise associated with these vessels, or both. Impacts from collisions are a direct impact from the presence of vessels. Collisions with vessels also are a potential source of injury (NMFS, 2008d). Vessels could affect whales through the physical presence and activity of the vessel; vessel strikes are rare, but do occur and can result in injury (NMFS, 2008d). In rare instances, killer whales are injured or killed by collisions with passing ships and powerboats, primarily from being struck by the propeller blades (Baird, 2001; Carretta et al., 2001, 2004; Ford et al., 2000; Visser, 1999; Visser and Fertl, 2000). In British Columbia, killer whales were shown to respond to approaching boats by increasing their swimming velocities and swimming toward open water (Kruse, 1991). Vessel presence (without factoring in noise effects) increased the short- and long-term stress in killer whales of this study (Kruse, 1991).

As described in Section 4.3.6.6, collisions from vessels associated with the Proposed Action are not expected to occur, and are not known to have occurred in lower Cook Inlet to date. Furthermore the presence of PSOs, and avoidance protocols would further lessen the likelihood of any ships striking a killer whale. Therefore, the impacts to killer whales from vessel traffic are expected to be negligible.

Accidental Oil Spills and Gas Release

Because small refined offshore oil spills dissipate rapidly, they would have a negligible level of effects on killer whales. Killer whales may be adversely affected by large spills as described in Section 4.3.6.7.

The effects of small and large oil spills on killer whales would be similar to what was described for beluga whales. As with beluga whales, the presence of spill response, and spill containment/cleanup protocols would ensure oil spills would have a negligible level of effects on killer whales.

Conclusion

Seafloor disturbance and habitat alteration, noise, vessel and aircraft traffic, and accidental oil spills and gas releases would have a negligible level of effects on killer whales.

Harbor Porpoise (*Phocoena phocoena*)

The Gulf of Alaska stock of harbor porpoises appear to be widespread throughout Cook Inlet, and occasionally large aggregations occur in coastal and offshore waters of lower Cook Inlet (Shelden et al., 2014).

Seafloor Disturbance and Habitat Alteration

Harbor porpoises appear to be extremely sensitive to disturbance and habitat degradation (CDFO, 2009). Urbanization of coastal areas may result in physical exclusion of harbor porpoises from their preferred shallow water habitats (CDFO, 2009). In addition, these activities, related ancillary works, and related vessel traffic can create localized increases in ambient noise levels and contribute to acoustic disturbance of porpoises. Physical or acoustic degradation of habitat may displace harbor porpoises and affect their potential to feed, their reproductive success, and their social behavior (CDFO, 2009). As a chronic threat involving many combined activities, this may lead to reduced individual and population fitness through compensatory behavioral changes (CDFO, 2009).

Activities stemming from the Proposed Action that may cause seafloor disturbance and habitat alteration are discussed in Sections 4.2 and 4.3.6. The most likely impact from seafloor disturbance and habitat alteration from these activities is to harbor porpoise prey species; however, as described in Section 4.3.2.1, the area affected over time is too limited to have measurable adverse effects to populations of fish and shellfish in the defined area. For these reasons the effects of seafloor disturbance and habitat alteration on harbor porpoises would be similar to, but less than those described for beluga whales, that being a negligible level of effects.

Noise

Harbor porpoises hear in high-frequency bands (20 Hz to 200 kHz) (Ciminello et al., 2012; Southall et al., 2007). In the Proposed Action, seismic noise would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, and echosounders. Harbor porpoises may be affected though sonar noise produced during ancillary activities; however, this noise is directed to a narrow area on the seafloor.

During the exploration phase, some harbor porpoises could be affected by noise from activities described within the Proposed Action, although individuals in the area should avoid detectable noise sources, and thus eliminate physiological damage to their hearing. Richardson (1995) noted odontocetes generally habituate well to the presence of drilling and production wells. Bach et al. (2010) confirmed offshore platforms and drilling activities pose no threat to small harbor porpoises or other small cetaceans, while production platforms may increase the presence of prey items by serving as artificial reefs.

During exploratory drilling, production wells and platforms would be constructed. The loudest noise associated with production platform construction would be pile driving to anchor the platform to the seafloor (up to 250 dB_{p-p} dB re 1 uPa^2) (see Table 4.2.5-1). As the audible frequency range of harbor porpoises is in the 20 to 200 kHz range, they would be able to hear pile driving noise associated with production platforms. Without much overlap in drilling, pile driving and construction noise frequencies with harbor porpoise audible frequency range, some pile driving noise would remain inaudible to harbor porpoises.

Pipeline construction would likely begin with platform construction. Dredging activities associated with laying subsea pipelines produce noises above ambient levels at frequencies of 20 to 700 Hz, which is within the audible frequency range for harbor porpoises (Greene and Moore, 1995). Thomson and Johnson (1996) documented decibel levels of 112 dB re 1 µPa @ 1.4 km (0.9 mi) from the drilling rig *Molikpaq*, with most of the energy occurring below 20 Hz, just at the lowest accepted auditory bandwidth for harbor porpoises.

Considering past observations in other areas where harbor porpoises have deliberately approached offshore drilling, construction, and platforms closely, the unmitigated effects of these IPFs on harbor porpoises will likely be negligible. The presence of PSOs, avoidance protocols, ramp-up, shutdown, and other mitigation procedures would ensure the Proposed Action would only have a negligible level of effects on harbor porpoises.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have negligible effects on harbor porpoises. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a, 1985b). NMFS typically requires a 1,000 ft (305 m.) minimum altitude for aircraft operating in Cook Inlet, Alaska, which would further reduce the effects of aircraft traffic and noise on harbor porpoises.

Vessel Traffic

Like many other cetaceans, harbor porpoises can rest at the surface (CDFO, 2009). Harbor porpoise habitat overlaps with urbanized marine environments, which increases their vulnerability to vessel strikes (CDFO, 2009). However, harbor porpoises are reclusive and tend to move away from boats and ships (Owl Ridge Natural Resources, 2014). Reactions to boats can be strong within 400 m (1,312 ft) (Polachek and Thorpe, 1990) out to 1.5 km (0.93 mi) (Barlow, 1988; Palka, 1993). Harbor porpoises have often been seen changing direction in the presence of vessel traffic (Richardson et al., 1995). Avoidance has been documented up to 1 km (0.6 mi) away from an approaching vessel, but the avoidance response is strengthened in closer proximity to vessels (Barlow et al., 1998; Palka, 1995). The presence of PSOs onboard vessels, as well as avoidance protocols should ensure a negligible level of effects on harbor porpoises.

Accidental Oil Spills and Gas Release

Because small refined offshore oil spills dissipate rapidly, they likely would have negligible effects on harbor porpoises. Harbor porpoises may be adversely affected by a large spill as described in Section 4.3.6.7.

The highest percent chance a large spill will contact harbor porpoise ERAs is described in Section 4.3.6.7. Harbor porpoises are listed as vulnerable in these areas from June to December (Appendix A, Table A.1-8) but may be present year-round. Upon contacting spilled oil, harbor porpoises may experience inhalation, ingestion, and skin and conjunctive tissue irritation. Harbor porpoises may not be able to detect or may not avoid contact with oil, as there were numerous observations of harbor porpoises swimming through light to heavy crude oil sheens (Harvey and Dahlheim, 1994). Findings from studies of potential associations between chronic exposure to polychlorinated biphenyls (PCBs) and infectious disease mortality in harbor porpoises from England and Wales were "…consistent with the hypothesis that chronic PCB exposure predisposes harbour porpoises in United Kingdom waters to infectious disease mortality…" (Jepson et al., 1999).

The fisheries prey base of harbor porpoises 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. Harbor porpoises could be excluded or redistributed from their habitat if the forage fish prey base was measurably reduced or eliminated for even a short period of time.

The effects of small and large oil spills on killer whales would be the same as what was described for beluga whales, and killer whales. As with those other species, the presence of spill response, and spill containment/cleanup protocols would ensure oil spills would have a negligible level of effects on harbor porpoises.

Conclusion

Seafloor disturbance and habitat alteration, noise, drilling, vessel and aircraft traffic, and accidental oil spills and gas releases would have a negligible level of effects on harbor porpoises.

Dall's Porpoise (*Phocoenoides dalli*)

Dall's porpoises (*Phocoenoides dalli*) are widely distributed throughout the North Pacific Ocean, including Alaska (Allen and Angliss, 2015), and prefer deep offshore and shelf slope waters (NMFS, 2015b). Dall's porpoises are present year-round throughout their entire range in the northeast Pacific from Baja California to Alaska, including the Gulf of Alaska, and are only occasionally seen in Cook Inlet (Morejohn, 1979). Due to the scarcity of Dall's porpoises in Lower Cook Inlet the localized effects of vessel and aircraft traffic, and noises from the Proposed Action could not affect them and will not be analyzed.

Seafloor Disturbance and Habitat Alteration

Impacts to Dall's porpoises from seafloor disturbance and habitat alteration from reduced prey availability are not expected to be substantial. As described in Section 4.3.5, the area potentially affected is too limited to have measurable adverse effects to populations of fish and shellfish in the defined area. For these reasons the effects of seafloor disturbance and habitat alteration on Dall's porpoises would be similar to, but less than those described for beluga whales, thus a negligible level of effects to Dall's porpoise is expected.

Accidental Oil Spills and Gas Release

Because small, refined offshore oil spills dissipate rapidly, they would not likely have substantial effects on Dall's porpoises. Dall's porpoises may be adversely affected by a large spill as described in Section 4.3.6.7. Potential exposure and impacts to this species are discussed here.

The highest percent chance that a large spill will contact Dall's porpoise ERAs is described in Section 4.3.6.7. Dall's porpoises are deemed vulnerable in these areas from June to August (Appendix A, Table A.1-8), and concentrations of Dall's porpoises have been reported in Shelikof Strait and around Kodiak and Afognak Islands (USDOI, MMS, 2003). Upon contacting spilled oil, Dall's porpoises may experience inhalation, ingestion, and skin and conjunctive tissue irritation. Dall's porpoises may not be able to detect or may not avoid contact with oil, as there were numerous observations of Dall's porpoises swimming through light to heavy crude oil sheens (Harvey and Dahlheim, 1994).

The fisheries prey base of Dall's porpoises 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. Dall's porpoises could be excluded from the Kodiak/Shelikof Strait area if their fish prey base is substantially reduced or briefly eliminated. Spill response protocols, personnel, and infrastructure in lower Cook Inlet, as well as the size of the assumed spills would keep the effects of small and large spills at negligible levels of effect.

Conclusion

Seafloor disturbance and habitat alteration, and accidental oil spills and gas releases would have a negligible level of effects on Dall's porpoises.

Humpback Whale (*Megaptera novaeangliae*) (Endangered)

In the summer, humpback whales are regularly present and feeding in areas near and within the proposed Lease Sale Area, including Shelikof Strait, the bays of Kodiak Island, and the Barren Islands, near the Kenai and Alaska Peninsulas, Elizabeth Island, and south of the Aleutian Islands. Humpback whales also may be present in some of these areas in the fall. Recent estimates of humpback whale abundance near the proposed Lease Sale Area have estimated a few hundred whales in Kenai waters (Von Ziegesar, Goodwin, and Devito, 2000; Waite et al., 1999), and more than 1,600 whales along the Aleutian Islands and the Alaska Peninsula from Kenai to Unimak Pass, including Kodiak Island, the Shumagin Islands, and north of Unimak Pass; the OSRA extent is in the northern range (Zerbini et al., 2007).

Seafloor Disturbance and Habitat Alteration

In-water construction activities frequently involve pile-driving, dredging, and filling, which could result in displacement, injury, or mortality of humpback whales (NMFS, 1991). These adverse effects can be mitigated or eliminated through seasonal restrictions to avoid construction during spring and summer seasons, or construction design modifications (NMFS, 1991). Mysticetes tend to avoid drilling units within audible range (Richardson et al., 1995; Schick and Urban, 2000). Therefore, it is unlikely that the whales will swim or feed in close enough proximity of discharges (i.e., drilling waste) to be affected (Richardson et al., 1995; Schick and Urban, 2000). The levels of drilling waste discharges are regulated by the NPDES exploration facilities general permit. The impact of drilling waste discharges would be localized and temporary. Impacts to cetacean food sources from the discharge of drilling fluid and cuttings would likely be limited to a localized area and would not be substantial at a landscape level. Consequently there should be a negligible level of effects from drilling discharges on humpback whales.

While the actual physical loss of habitat may be small in comparison to the total habitat available, secondary effects associated with the initial habitat modification may have negative consequences on the distribution and reproductive success of humpback whales (NMFS, 1991). Examples of such impacts might include increased vessel traffic associated with harbors as well as degradation of water quality from increased surface runoff (NMFS, 1991). Seafloor disturbance and habitat alteration from Proposed Action activities may have small localized impacts to zooplankton (see Section 4.2.1), important prey species for humpback whales; however, the effects are expected to be localized and are not expected to substantially impact humpback whales. For these reasons the effects of seafloor disturbance and habitat alteration on humpback whales would be similar to, but less than those described for beluga whales, and therefore a negligible level of effects.

Noise

Seismic operations are expected to occur in the first 3 years of the Proposed Action. Mysticetes generally avoid operating airguns, but avoidance radii are variable among species, locations, whale activities, and oceanographic conditions affecting sound propagation (Gordon et al. 2004; Richardson et al., 1995). Whales have also been reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much greater distances.

Mysticetes have shown tolerance of vessels and sonar operations; however, when exposed to strong sound pulses from airguns, they often react by deviating from their normal migration route or interrupting their feeding and moving away (Gordon et al., 2004; Johnson et al., 2007; Malme and Miles, 1985; Malme et al., 1984, 1985, 1988; McCauley et al., 1998, 2000a, 2000b; Nowacek et al., 2007; Richardson, 1995; Weir, 2008). Although mysticetes can show only slight overt responses to operating airgun arrays (Stone and Tasker, 2006; Weir, 2008), strong avoidance reactions by several species of mysticetes have been observed at ranges of 6 to 8 km (3.5 to 5 mi) and occasionally as far as 20 to 30 km (12 to 19 mi) from the source vessel when large arrays of airguns were used.

Experiments with a single airgun showed that humpback and gray whales showed localized avoidance to a single airgun of 20 to100 in^3 capacity (Malme et al., 1984, 1985, 1988; McCauley et al. 1998, 2000a, 2000b), while other studies of gray and humpback whales found that seismic pulses with received SPL_{rms} of 160 to 170 dB re 1 µPa @ 1 m cause obvious avoidance behavior in a substantial portion of animals (Richardson, 1995). In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 4 to 15 km (2 to 10 mi) from the source.

In the case of migrating whales, observed changes in behavior appeared to be of little or no biological consequence to the animals; they simply avoided the sound source by displacing their migration route to varying degrees, but still within the natural boundaries of the migration corridors (Malme and Miles 1985; Malme et al. 1984; Richardson, 1995). Feeding whales, in contrast to migrating whales, show much smaller avoidance distances (Harris et al., 2007; Miller et al., 2005), presumably because moving away from a food concentration has greater cost to the whales than a course deviation during migration.

Noise associated with well drilling and accompanying small and large support vessel noises expected in years 2 to 5 of the Proposed Action may produce negligible to minor effects on humpback whales. The most likely effect would be avoidance.

In general, mysticetes react strongly and consistently to approaching vessels of a wide variety of types and sizes. Whales are anticipated to interrupt their normal behavior and swim rapidly away if approached by a vessel. Surfacing, respiration, and diving cycles can be affected. The flight response often subsides by the time the vessel has moved a few kilometers away. After single disturbance incidents, at least some whales are expected to return to their original locations. Vessels moving slowly and in directions not toward the whales usually do not elicit such strong reactions (Richardson and Malme, 1993).

Underwater sound propagation results from the use of generators, drilling machinery, and the rig itself. The level of sound propagation would depend on 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, and underwater sound appeared to be lower at the bow and stern of the drillship compared to the beam (Greene, 1987).

During drilling operations, the MODU would produce low-frequency noises. Drillships are louder and generate more noise in the water 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 several 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 in frequency or decibel level to produce physiological effects on marine mammals.

Pile driving is a technique used to fix production platforms to the seafloor in the proposed Lease Sale Area. Pile driving is an impulsive noise source (unless a specifically vibratory source is used) expected to produce PSLs up to 250 dB re 1 μPa and emit frequencies in the 100 to 500 Hz range, frequencies that are audible to humpback whales. Although the 250 dB SPL is well above the Level A (180 dB re 1 μPa) and Level B (160 dB re 1 μPa) harassment thresholds used by NMFS, the impacts to humpback whales are likely minor as the noise levels are expected to drop considerably in a relatively short distance from the source (Blackwell, 2005; Green and Moore, 1995), and humpback whales are likely to detect and avoid these activities.

The low-frequency percussive noise produced by pile driving would be detectable to marine mammals several kilometers from the activity. However, the decibel levels would remain insufficient to elicit any physiological responses among marine mammals in or near the proposed Lease Sale Area. Marine mammals in the vicinity of the noise source would likely exhibit temporary behavioral responses to such noises such as avoidance or skittishness.

Other construction noises during development may include dredging and pipeline installation. 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 (15.5 mi) in nearshore areas.

Considering the physiology, and distribution of humpback whales in Lower Cook Inlet, and considering the presence of PSOs, start-up, shut-down, ramp-up, and avoidance procedures typically required by the NMFS, noise from the Proposed Action should have negligible effects on humpback whales.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have a negligible level of effects on humpback whales. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a, 1985b).Furthermore one of the standard mitigations required by the NMFS is a minimum altitude requirement of 1,000 ft above sea level for aircraft to ensure marine mammals remain undisturbed. The effects of aircraft traffic on humpback whales would therefore be negligible before and after NMFS mitigations, though the mitigations would lessen the actual effects on this species.

Vessel Traffic

Collisions with ships are an increasing threat to many whale species (NMFS, 1991). If the numbers of vessels or whales increase in a given area, the incidence of collisions may also be expected to increase (NMFS, 1991). Humpback whale reactions to approaching vessels are variable, ranging from approach to avoidance (Payne, 1978; Salden, 1993). Humpback whales in Alaska significantly changed their respiratory patterns relative to vessel speed, proximity, and presence of large ships (Baker et al., 1983). Humpback whales with calves in Australia were less likely to exhibit a variety of surface behaviors, and dove more often when vessels were within 300 m (984 ft) compared to when vessels were absent (Corkeron, 1995).

On rare occasions, humpback whales “charge” toward a boat and “scream” underwater, apparently as a threat (Payne, 1978). Baker et al. (1983) reported that humpback whales in Hawaii responded to vessels at distances of 2 to 4 km (0.5 to 2.5 mi). Bauer and Herman (1986) concluded that reactions to vessels are probably stressful to humpback whales. Humpback whales seem less likely to react to vessels when actively feeding than when resting or engaged in other activities (Krieger and Wing, 1984). Mothers with newborn calves seem most sensitive to vessel disturbance (Clapham and Mattila, 1993). Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting to active behavioral states, which would imply they incur an energy cost. Morete, Bisi, and Rosso (2007) reported that undisturbed humpback whale mothers that were accompanied by their calves were frequently observed resting while their calves circled them (milling) as well as rolling interspersed with dives. When vessels approached, the amount of time mothers and calves spent resting and milling, respectively, declined significantly (Morete, Bisi, and Rosso 2007).

Humpback whales in the southern portions of the proposed Lease Sale Area could be negatively affected by vessel transport and construction activities (USDOI, MMS, 2003). However, this area has a high volume of fishing- and tourism-related vessel traffic in the summer months when the whales are present. The incremental addition of noise from the anticipated (small) number of vessels per day associated with the Proposed Action is unlikely to add markedly to the existing levels of noise.

Humpback whales in particular have been studied relative to reactions to cruise ships and tankers, with results showing a general avoidance reaction at distances from 2 to 4 km (0.5 to 2.5 mi) (Baker et al., 1982, 1983), and no reaction at distances of 800 m (2,625 ft) when the whales were feeding (Watkins et al., 1981; Kriiger and Wing, 1986). Also, humpback whales are especially responsive to fast-moving vessels (Richardson et al., 1995), and often react with aerial behaviors such as breaching or tail/flipper slapping (Jurasz and Jurasz, 1979). However, temporarily disturbed whales often remain in the area despite the presence of vessels (Baker et al., 1988, 1992).

The number of humpback whales killed worldwide by ship strikes is exceeded only by fin whales (Jensen and Silber, 2004). On the Pacific coast, a humpback whale is killed approximately every other year by ship strikes (Barlow and Clapham, 1997). There were 108 reports of whale-vessel collisions in Alaska waters between 1978 and 2011 (NMFS, 2015c). Of these, 93 involved humpback whales (Neilson et al., 2012). Between 2007 and 2011, the mean minimum annual human-caused mortality and serious injury rate for humpback whales based on vessel collisions in Alaska (0.36) was reported in the NMFS Alaska Regional Office stranding database (Allen and Angliss, 2015). The high proportion of calves and juveniles among stranded ship-struck right whales and humpback whales indicates that young animals may be more vulnerable to being struck by ships (Laist et al., 2001). This could be caused by the relatively greater amount of time that calves and juveniles spend at the surface or in shallow coastal areas where they are vulnerable to being hit (Laist et al., 2001). Considering that humpback mother/calf pairs have been sighted in the proposed Lease Sale Area and OSRA study area, these individuals may be more susceptible to ship strikes from vessels associated with the Proposed Action. Mitigation measures required by NMFS (e.g., PSOs onboard vessels, vessel speed restrictions, etc.) will likely eliminate or reduce the adverse impacts to humpback whales from vessel traffic to negligible levels of effect.

Accidental Oil Spills and Gas Release

Because small refined offshore oil spills dissipate rapidly, they likely would not have noticeable adverse effects on humpback whales. Humpback whales may be adversely affected by a large spill as described as described in Section 4.3.6.7. Potential exposure and impacts to this species are discussed here.

The highest percent chance that a large spill will contact humpback whale ERAs is described in Section 4.3.6.7. Humpback whales are at highest risk from impacts to oil spills during the summer and fall in their feeding areas around Kodiak Island. Three of the four ERAs with a percent chance of contact from a large spill occur around Kodiak Island, an area deemed a feeding BIA for humpback whales (Ferguson, Curtis, and Harrison, 2015). The highest densities of humpback whales in this BIA occur from July through September (Witteveen et al., 2007, 2011). The fourth ERA occurs just north of the BIA, on the southern extent of the Kenai Peninsula, another area of high use by humpback whales in the summer.

Upon contacting spilled oil, humpback whales may experience inhalation, ingestion, and skin and conjunctive tissue irritation similar to other whales. Because they also are mysticetes, humpback whales may experience baleen fouling as well.

Humpback whales may or may not be able to detect oil or may not avoid it if they can detect it, thus increasing their risk of contacting oil. Several investigators have observed various cetaceans in spilled oil, including humpback whales, fin 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 M/V *Regal Sword*, Geraci and St. Aubin (1990) 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. 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.

Repeated surfacing within a large spill with fresh oil with high levels of volatile toxic hydrocarbon fractions present could lead to organ damage and mortality of humpback whales. These whales prey on schools of forage fish (e.g., capelin, sand lance, herring) as well as copepods and euphausiids in the water column and on the surface, which may have spilled oil present. Consumption of contaminated prey, and the reduction or mortality of local prey populations could create periods whereby summer prey would not be available for an undetermined time period depending on prey recovery rates.

Because of their distribution, the primary potential adverse effect on humpback whales would be from a large spill that contacted waters adjacent to Kodiak Island, including Shelikof Strait, especially during the summer and fall when densities are highest in this area.

As discussed previously, the highest percent chance of contact from a large spill is to the Kodiak and Shelikof Strait area, area feeding BIA for humpback whales (Ferguson, Curtis, and Harrison, 2015). Humpback whales are top-level generalist predators, known to eat pelagic schooling fishes, euphausiids, and other large zooplankton (Nemoto and Kawamura, 1977; Witteveen et al., 2011).

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. This research also indicated that copepods may passively accumulate PACs from the water and could serve as a conduit for the transfer of PACs to higher trophic level consumers. Duesterloh, Short, and Barron (2002) concluded that phototoxic effects on copepods could cause ecosystem disruptions that have not been accounted for in traditional oil spill damage assessments. As such, the greatest impact of an oil spill on humpback whales could occur indirectly. Local depletion of food resources may occur as a result displacement and mortality of food species. Some species of euphausiids and other crustaceans may be highly susceptible to the toxic effects of oil and they are essentially unable to move away from the site of a spill (Rice et al., 1984). Other species such as herring, capelin, and sand lance could be affected by mortality of eggs and immature life stages, thereby reducing recruitment to the size classes used by humpback whales. Under most circumstances, a large portion of a year class is not likely to encounter the same spill. However, a large spill that can spread vast distances could cause large perturbations in the productivity or distribution of many prey species, including pelagic breeders (NMFS, 1991).

Humpback whales may be affected by exposure to PACs through their food as they may swallow oil-contaminated prey and ingest dissolved or floating oil fractions incidental to food intake. Von Ziegesar, Miller, and Dahlheim (1994) found no indication of a change in abundance, calving rates, seasonal residency time of mother-calf pairs, or mortality in humpback whales as a result of the Exxon Valdez Oil Spill, although they did see temporary displacement from some areas of Prince William Sound.

Some zooplankton (eaten by humpback whales) may 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 mysticetes. This suggests that prey have low concentrations in their tissues, or that mysticetes may be able to metabolize and excrete certain petroleum hydrocarbons.

A large spill, depending on the timing and location relative to the distribution and aggregations of zooplankton, could reduce feeding opportunities for humpback whales during the year of the spill. The significance of the loss of that opportunity to humpback whales' health depends on major feeding opportunities humpback whales may find later in the year to meet annual energy demands. Given that the OSRA model estimates that a large spill could contact the waters around Kodiak Island and the Shelikof Strait, an important feeding area for humpback whales, potential adverse impacts to their prey health and availability could occur.

Fate, recovery, and availability of zooplankton and fish populations to humpback whales in similar quantities and locations as pre-spill conditions in the proposed Lease Sale Area and the OSRA study area in subsequent years would depend on a variety of factors. Humpback whales are thought 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 humpback whales may experience multiple large and small polluting events as well as chronic pollution exposure within their lifetime.

After the Exxon Valdez Oil Spill, researchers studied the potential effects of an oil spill on cetaceans. Dahlheim and Loughlin (1990) documented negligible effects on humpback whales. Von Ziegesar, Miller, and Dahlheim (1994) found no indication of a change in abundance, calving rates, seasonal residency time of mother-calf pairs, or mortality in humpback whales as a result of that spill, although they did see temporary displacement in 1989 from some areas of Prince William Sound.

Taking into account the size of large spills (5,100 bbls platform/1,700 bbls pipeline), weathering and dispersion effects on spills in Lower Cook Inlet, and the presence of spill response personnel, plans, and infrastructure, the level of effects of large spills on humpback whales would most likely be negligible to minor.

Conclusion

Seafloor disturbance and habitat alteration, noise, aircraft and vessel traffic would have a negligible level of effects on humpback whales. The level of effects from an accidental oil spill or gas release on humpback whales would vary from negligible for a small spill to negligible to minor for a large spill.

Gray Whale (*Eschrichtius robustus*)

Gray whales approach the proposed Lease Sale Area in late March through June and leave again in November and December (Consiglieri et al., 1982; Rice and Wolman, 1971). Although there have been numerous sightings of gray whales in Shelikof Strait, most of the population follows the outer coast of the Kodiak archipelago from the Kenai Peninsula in spring or the Alaska Peninsula in fall. Spring concentrations occur along eastern Afognak Island and the northeastern, central, and southeastern Kodiak Island area during the spring and fall migrations (USDOI, MMS, 2003). Because the majority of gray whales migrating through the Gulf of Alaska region are thought to take a coastal route, one migratory corridor BIA in this region was defined by the extent of the continental shelf (Ferguson, Curtis, and

Harrison, 2015). The greatest densities of gray whales are found in this BIA southbound from November through January and northbound from March through May (Ferguson, Curtis, and Harrison, 2015).

Seafloor Disturbance and Habitat Alteration

Seafloor disturbance and habitat alteration from Proposed Action activities may have small localized impacts to benthic organisms (see Section 4.3.4.1) that are important prey species for gray whales. Gray whales are benthic feeders (Oliver and Slatery, 1985) and the seafloor area covered by accumulations of discharged drilling wastes will be unavailable to the whales for foraging purposes, representing an indirect impact on the animals. Such indirect impacts would have no meaningful effect on individual whales and negligible effect on the population since disturbance areas would be few, and collectively amount to a small portion of available foraging habitat in the proposed Lease Area, Cook Inlet, and the Gulf of Alaska. Considering the dearth of gray whale sightings in the Lease Area, and the limited effects of seafloor disturbance and habitat alteration in the Lease Area, the effects of on gray whales would negligible.

Noise

As most gray whales will occur outside of the proposed Lease Sale Area, the noises associated with IPFs are not likely to reach the Gulf of Alaska migratory corridor described previously, and so impacts from sound are expected to be negligible to gray whales. If sound levels are detected in the Gulf of Alaska, some deflection may occur. Malme et al. (1983, 1984, 1986) studied the behavioral responses of gray whales that were migrating along the California coast to various sound sources located in their migration corridor. The whales showed statistically significant responses to four different underwater playbacks of continuous sound at received levels of approximately 120 dB re 1 µPa @ 1 m. The sources of the playbacks were typical of a drillship, semisubmersible, drilling platform, and production platform. Up to 50% of migrating gray whales deflected from their course when the received level of industrial noise reached 116 to 124 dB re 1 µPa, and disturbance of feeding activity may occur at sound levels as low as 110 dB re 1 µPa (Malme et al., 1986). For these reasons noise from the Proposed Action would have a negligible level of effects on gray whales.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have negligible effects on gray whales, a species that mostly occurs south of the Lease Area. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a, 1985b). Due to the dearth of gray whale sightings in the proposed Lease Sale Area, and standard NMFS mitigations requiring a 1,000 ft altitude above sea level, there would be a negligible level of effects of aircraft traffic on gray whales.

Vessel Traffic

Between 1999 and 2003, the California stranding network reported only four serious injuries or mortalities of gray whales caused by ship strikes, and only one reported in Alaska (Allen and Angliss, 2012). As described earlier, gray whales are likely to avoid vessel traffic, and no collisions with vessels have been reported in Cook Inlet to date (pers. comm. Barbara Mahoney, NMFS, 1 February 2016). Because few gray whales should occur in the proposed Lease Sale Area, and because those individuals that do occur in lower Cook Inlet are expected to avoid vessels, vessels are expected to have a negligible level of effects this species.

Accidental Oil Spills and Gas Release

Small refined offshore oil spills dissipate rapidly, and due to their small size, they likely would have negligible effects on individual gray whales. No population level effects to gray whales could occur from small spills associated with the Proposed Action. Gray whales may be adversely affected by a large spill as described in Section 4.3.6.7. Potential exposure and impacts to this species are discussed here.

The highest percent chance that a large spill will contact gray whale ERAs is described in Section 4.3.6.7. All of the ERAs occur around Kodiak Island and adjacent to the Alaska Peninsula, areas deemed as migratory BIAs for gray whales (Ferguson, Curtis, and Harrison, 2015). As the highest densities of gray whales in this migratory BIA occur from November to January when whales are southbound and from March to May when whales are northbound (Braham, 1984a,b; Rugh, 1984; Rugh, Shelden, and Schulman-Janiger, 2001), gray whales would have a higher risk of exposure to oil if a large oil spill occurred during these times. Additionally, ERAs 95 and 98 occur in gray whale feeding BIAs (Ferguson, Curtis, and Harrison, 2015). Because the greatest densities of whales in this BIA occur from June to August (Moore et al., 2007; Witteveen, pers. comm., 12 January 2015, as cited in Ferguson, Curtis, and Harrison, 2015; Wynne and Witteveen, 2005, 2013), gray whales would be at increased risk of exposure to oil during this time period.

Upon contacting spilled oil, gray whales may experience effects from inhalation, ingestion, baleen fouling, and skin and conjunctive tissue irritation. Gray whales may not be able to detect oil or may not avoid it if they can detect it. Evans (1982) observed that gray whales typically swam through oil seeps off California. Though those whales modified their swim speeds and breathing rates, there were no consistent behavioral patterns relating to the oil spill. Numerous gray whales were observed swimming through light to heavy crude oil sheens following the Exxon Valdez Oil Spill (Harvey and Dahlheim, 1994). Days after the spill an aerial reconnaissance flight observed gray whales swimming lethargically at the surface, while noting oil fumes could be detected in the plane at 200 m (656 ft) altitude (J. Lentfer, pers. comm., as cited in Harvey and Dahlheim, 1994).

Laboratory tests suggest gray whale baleen, and possibly skin, may be resistant to oil damage. Gray whales exhibiting abnormal behavior were observed after the Exxon Valdez Oil Spill in an area where fumes from the spill were very strong (J. Lentfer, pers. comm., as cited in Harvey and Dahlheim, 1994). Subsequently, large numbers of gray whale carcasses were discovered. One of three of these had elevated levels of PAHs in its blubber; however, Loughlin (1994) concluded it was unclear what caused the death of those whales. An estimated 80,000 bbl of oil spilled in waters off Santa Barbara in 1969, as gray whales were beginning their northbound migration. Though whales were observed migrating through the slick, and six dead gray whales were observed and recovered, no evidence of oil contamination was found among the carcasses, and the numbers of dead whales were deemed within the natural range of what should be expected.

If small or large groups of gray whales become exposed to sufficiently large amounts of fresh oil from a spill, especially through inhalation of aromatic fractions, they could be injured or die from the exposure. Though little evidence links gray whale deaths or injuries to oil exposure, an increase in gray whale deaths coincided with the Exxon Valdez Oil Spill and concurrent observations of gray whales in oil. If fresh oil from a large spill contacted important habitats (Table 4.3.2-15), some gray whales could experience multiple cases of injury or mortality during migration.

Gray whales may ingest oil fractions that sink to or persist in seafloor sediments that become disturbed gray whales crater the sea floor for food. Chronic consumption of bottom-accrued oil fractions or contaminated prey could impair endocrine function, reproduction, or produce mortalities (Geraci, 1990). Tissue studies by Geraci and St. Aubin (1990) found low levels of naphthalene in the livers and blubber of mysticetes, suggesting prey species have low concentrations in their tissues, or mysticetes have the ability to metabolize and excrete some petroleum hydrocarbons.

Gray whales are considered generalist feeders, using three different feeding methodologies: (1) benthic foraging, (2) surface skim feeding, and (3) engulfing (Nerini, 1984). The Eastern North Pacific Stock of gray whales feed along their entire range from Arctic waters offshore of Alaska and Chukotka to subtropical waters off Mexico (e.g., Moore et al., 2007; Nerini, 1984; Weller et al., 1999). Though a variety of invertebrate prey species have been found in gray whale stomachs, benthic foraging on a few species is thought to be their primary and most productive feeding activity.

In lower Cook Inlet and the Gulf of Alaska, spilled oil could adversely affect gray whales by contaminating benthic prey and sediments, particularly in prime feeding areas (Moore and Clarke, 2002; Würsig, 1990). Any perturbation such as a large spill that 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 Cadiz* oil spill in 1978, which was 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).

Losses within benthic prey in larval stages living in the water column or reduced benthic biomass, and productivity of nearshore and offshore shoals could force gray whales to seek alternate, less optimal foraging areas elsewhere for up to several years until the affected communities recover. Impacts to a few gray whales could occur over a period of several years, depending on the quantities of oil fractions remaining in the environment, any long-term effects of the oiling on prey species, and the state of other feeding habitat. Due to the low numbers of gray whales expected to occur in Lower Cook Inlet, the brief duration of a large spill, weathering processes, spill response protocols, and the assumed sizes of large spills (5,100 bbl platform/1,700 bbl pipeline) large spills from the Proposed Action should have negligible to minor effects on gray whales.

Conclusion

Seafloor disturbance and habitat alteration, noise, aircraft and vessel traffic would have a negligible level of effects on gray whales. The level of effects from an accidental oil spill or gas release on gray whales would vary from negligible for a small spill to negligible to minor for a large spill.

Fin Whale (*Balaenoptera physalus*) (Endangered)

In Alaska, fin whales are found as far north as the western Chukchi Sea, the Bering Sea, and throughout the Gulf of Alaska (Clark, 2008). These whales inhabit areas near within the OSRA study area, including Shelikof Strait, Kodiak Island—particularly on the west side, and the Gulf of Alaska (Witeeven, pers. comm., 12 January 2015, as cited in Ferguson, Curtis, and Harrison, 2015; Zerbini et al. 2007). The majority of these areas are feeding grounds for the fin whale (Ferguson, Curtis, and Harrison, 2015).

Seafloor Disturbance and Habitat Alteration

Seafloor disturbance and habitat alteration from Proposed Action activities may have small localized impacts to organisms (see Section 4.2.1) that are important prey species for fin whales. However, due to the localized nature of the impacts, the effects are not expected to substantially affect fin whales. For these reasons the negligible level of effects from seafloor disturbance and habitat alteration on fin whales would be similar to, but less than those described for beluga whales.

Mysticetes tend to avoid drilling units at distances up to 20 km (12 mi) (80 *FR* 11726, March 4, 2015). Therefore, it is highly unlikely that mysticetes will swim or feed in close enough proximity of discharges (i.e., drilling waste) to be affected (80 *FR* 11726, March 4, 2015). The levels of drilling waste discharges are regulated by the NPDES exploration facilities general permit. The impact of drilling waste discharges would be localized and temporary. Impacts to cetacean food sources from the discharge of drilling fluid and cuttings would likely be limited to a localized area and would not be substantial at a landscape level. For these reasons seafloor disturbance and habitat alteration from the Proposed Action would have a negligible level of effects on fin whales.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have a negligible level of effects on fin whales. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a, 1985b). Furthermore, one of the standard mitigations required by the NMFS is a 1,000 ft above sea level minimum altitude requirement for aircraft to ensure marine mammals remain undisturbed.

Vessel Traffic

Around the world, fin whales are killed and injured in collisions with vessels more frequently than any other whale (Douglas et al., 2008; Jensen and Silber, 2004; Laist et al., 2001). Based on ship-strike records, immature fin whales appear to be particularly susceptible to strike (Douglas et al., 2008). Differences in frequency of injury types among species may be related to morphology (NMFS, 2015e). The long sleek fin whale tends to be caught on the bows of ships and carried into port where they are sometimes found and recorded in stranding databases (Laist et al., 2001). There have been 108 reports of whale-vessel collisions in Alaska waters between 1978 and 2011 (NMFS, 2015e). Of these, three involved fin whales (Neilson et al., 2012), but none have been reported in lower Cook Inlet (pers. comm. Barbara Mahoney, NMFS, 1 February 2016). Some of the unique feeding habits of fin whales may also put them at a higher risk of collision with vessels than other mysticetes (NMFS, 2015e). Fin whales lunge feed instead of skim feed (USDOI, BOEM, 2011c). The lunges are quick movements that may put fin whales in the path of an oncoming vessel, giving vessels little time to react. In addition fin whales appear to be limited to short dive durations (Goldbogen et al., 2007), which might make them more susceptible to ship strikes when they are near the surface.

Fin whales responded to vessels at distances of approximately 1 km (0.6 mi) (Edds and Macfarlane, 1987). Watkins (1986) found that fin and humpback whales appeared startled and increased their swimming speed to avoid approaching vessels. Jahoda et al. (2003) studied responses of fin whales in feeding areas when they were closely approached by inflatable vessels. The study concluded that close vessel approaches caused the fin whales to swim away from the approaching vessel and to stop feeding. These animals also increased their blow rates and spent less time at the surface (Jahoda et al., 2003), suggesting increases in metabolic rates as a possible stress response. These responses can manifest as a stress response in which the animal undergoes physiological changes with chronic exposure to stressors; it can interrupt essential behavioral and physiological events, alter time budget, or be a combination of these responses (Frid and Dill, 2002b; Sapolsky, 2000).

Fin whales in the proposed Lease Sale Area could be negatively affected by vessel transport (USDOI, MMS, 2003); however, the area has a high volume of fishing- and tourism-related vessel traffic in the summer months, making the incremental addition of noise from the anticipated number of vessels per day associated with the Proposed Action unlikely to substantially add to the impacts from existing levels of vessel traffic. Because of the scarcity of fin whales in the Lease Area, the tendency of fin whales to avoid vessels, and the levels of pre-existing vessel traffic in the Lease Area, vessel traffic should have a negligible level of effects on fin whales. The typical suite of mitigation measures required by the NMFS includes the use of PSOs, and avoidance protocols that would further lessen the likelihood of Proposed Action vessel traffic having adverse effects on fin whales. For these reasons the mitigated effects of the proposed vessel traffic would continue to have a negligible level of effects on fin whales.

Accidental Oil Spills and Gas Release

Because small refined offshore oil spills dissipate rapidly, they should have negligible effect on fin whales. Fin whales may be adversely affected by a large spill as described in Section 4.3.6.7. Potential exposure and impacts to this species are discussed here.

The highest percent chance that a large spill will contact fin whale ERAs is described in Section 4.3.6.7. These ERAs occur around Kodiak Island and the Shelikof Strait, areas deemed feeding BIAs for fin whales (Ferguson, Curtis, and Harrison, 2015). The highest densities of fin whales in this area occur from June through August, although they have been observed year-round by aerial and acoustic surveys and are deemed vulnerable throughout the year (Appendix A, Table A.1-8) (Clapham et al., 2012; Moore et al., 2006; Stafford et al., 2007; Witteveen, pers. comm., 12 January 2015, as cited in Ferguson, Curtis, and Harrison, 2015).

Upon contacting spilled oil, fin whales may inhale or ingest oil, or experience skin and conjunctive tissue irritation, or perhaps experience baleen fouling. Fin whales may be unable to detect or avoid oil, which could increase their risk of exposure. Several investigators have observed various cetaceans in spilled oil, including fin whales, humpback whales, gray whales, dolphins, and pilot whales (Harvey and Dahlheim, 1994; Smultea and Würsig, 1995). Typically, the whales did not avoid slicks but swam through them, showing no reaction to the oil. During the spill of Bunker C and No. 2 fuel oil from the M/V *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. These findings are supported by Geraci (1990) which found mysticetes and odontocetes did not seem to avoid oil (Geraci, 1990). Geraci (1990) reported fin whales, humpback whales, dolphins, and other cetaceans have been observed entering oiled areas and behaving normally. These studies, and others cited in other cetacean species oil spill impact discussions, suggest fin whales are not likely to be displaced from or avoid their preferred habitat based on the presence of oil alone.

A large spill could have adverse impacts to fin whales, especially given that the OSRA estimates a large spill may contact the Barren Islands and the waters adjacent to Kodiak Island, including Shelikof Strait during the summer. These are important feeding areas for fin whales, with highest densities of fin whales in the summer, and presence year-round.

In the Aleutian Islands and Gulf of Alaska, euphausiids were the most common prey in stomachs of fin whales hunted during whaling operations between 1952 and 1958, whereas schooling fishes predominated in the northern Bering Sea and off Kamchatka (Mizroch et al., 2009; Nemoto, 1959). Mizroch et al. (2009) concluded fin whales are probably present in waters of Shelikof Strait, off the Kodiak Archipelago, and other northerly areas in winter because of the prey presence and distribution in those areas. Contamination and reduction of food sources for fin whales from a large spill would be similar to impacts to food sources for humpback, and beluga whales. Since fin whales feed within the water column ocean currents, and weather should prevent spilled oil from lingering in fin whale feeding areas for lengthy time periods. A 5,100 bbl large spill from a production platform, or a 1,700 bbl from a pipeline would also have limited potential to affect fin whales due to the size of the spill, existing spill response plans and supporting infrastructure in Lower Cook Inlet, and the dispersion/weathering of the spill over hours or possibly days as the spill is released. In all likelihood an oil spill would be contained, partially recovered, and perhaps burned, such that it is highly unlikely any whales would be contacted by the spilled materials, especially considering the scarcity of fin whales. For these reasons small or large spills should have a negligible level of effects on fin whales.

Conclusion

Seafloor disturbance and habitat alteration, noise, aircraft and vessel traffic, and accidental oil spills and gas releases would have a negligible level of effects on fin whales.

Minke Whale (*Balaenoptera acutorostrata*)

Minke whales are most abundant in the Gulf of Alaska during summer, when they appear to become more sedentary in their movements, sometimes occupying individual seasonal local feeding ranges (Dorsey, 1981). Minke whales become scarce in the Gulf of Alaska in fall; most whales leave the region by October (Consiglieri et al., 1982). Minke whales are migratory in Alaska but recently have been observed off Cape Starichkof and Anchor Point year-round (Allen and Angliss, 2015).

Seafloor Disturbance and Habitat Alteration

The effects of seafloor disturbance and habitat alteration on minke whales would be similar to, but less than the negligible level of effects described for beluga whales.

Noise

The auditory abilities, sensitivities, and behaviors of minke whales are similar to fin and humpback whales, and the noise effects analyses for fin and humpback whales is applicable to minke whales. Low numbers of minke whales are expected to occur in the proposed Lease Sale Area; the standard suite of NMFS mitigations including the use of PSOs, avoidance protocols, start-up, shutdown, ramp-down, altitude restrictions, etc. would reduce the potential for adverse impacts from noise to negligible levels of effect.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have negligible level of effects on minke whales. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a, 1985b). Furthermore, one of the standard mitigations required by the NMFS is a 1,000 ft above sea level minimum altitude requirement for aircraft to ensure marine mammals remain undisturbed.

Vessel Traffic

Minke whales have been observed avoiding boats when approached and approaching boats when the boats are stationary (Richardson et al., 1995). Watkins (1986) noticed that over the years of exposure to ships in the Cape Cod area, minke whales changed from frequent positive interest (e.g., approaching vessels) to generally uninterested reactions. Minke whales are expected to respond to vessel traffic similarly to other mysticetes discussed in this chapter.

Minke whales in the proposed Lease Sale Area could be negatively affected by vessel transport and construction activities (USDOI, MMS, 2003). However, the area has a high volume of fishing- and tourism-related vessel traffic in the summer months when the whales are present. Because of the scarcity of minke whales in the Lease Area, the tendency of minke whales to avoid vessels, and the levels of pre-existing vessel traffic in the Lease Area, vessel traffic should have a negligible level of effects on them. The typical suite of mitigation measures required by the NMFS includes the use of PSOs, and avoidance protocols that would further lessen the likelihood of Proposed Action vessel traffic having adverse effects on minke whales. Consequently the mitigated effects of the proposed vessel traffic would continue to have a negligible level of effects on minke whales.

Accidental Oil Spills and Gas Release

Because small, refined offshore oil spills dissipate rapidly, and because of their small volume, they would likely have negligible effect on minke whales. Minke whales may be adversely affected by a large spill. ERAs were not determined for minke whales. However, as the minke whale range (NOAA, 2015b) extends into portions of the proposed Lease Sale Area and the OSRA study area, minke whales could occur in many of the ERAs discussed for other species. Potential exposure and impacts to this species are discussed here.

The effects of contact with spilled oil on minke whales are the same as was described for fin, humpback, and gray whales. Like humpback and fin whales, minke whales feed on schools of fish (e.g., capelin, sand lance, herring) and invertebrates such as copepods and euphausiids in the water column and at the water's surface (Hoelzel et al., 1989; Horwood, 1990; Nemoto, 1959, as cited by Consiglieri et al., 1982) where spilled oil could occur. Consuming contaminated prey and decreases in local fish populations could create periods when prey might be unavailable.

If minke whales are able to detect and choose to avoid spilled oil, a large spill could displace them from feeding areas, since impacts prey distribution and abundance would likely dictate the presence or absence of minke whales in an area. Considering minke whales are uncommon in the Lease Sale Area, and the estimated abundance of minke whales across the north Pacific, a large spill could not produce population-level effects to the minke whale population. Additionally, minke whale distribution and abundance in these areas could be modified or reduced in relation to the potential modification to food source distribution and abundance as result of a large spill. Oil-contacted minke whales would likely experience effects similar to those described for humpback whales. Considering the scarcity of minke whales in the Lease Area, their presence in the Gulf of Alaska, the limited size of a large spill, OSRA results within and beyond Lower Cook Inlet, the presence of spill response infrastructure, and the probability of a rapid spill response, the effects of a large spill on minke whales would be negligible.

Conclusion

Seafloor disturbance and habitat alteration, noise, aircraft and vessel traffic, and accidental oil spills and gas releases would have a negligible level of effects on minke whales.

Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

The Pacific white-sided dolphin is extralimital to the proposed Lease Sale Area; therefore, only large accidental spills could potentially impact this species and only the effects of large accidental spills will be discussed in this section. Species abundance is thought to be seasonally variable with rare presence during winter, becoming more abundant in spring (USDOI, MMS, 1984). During surveys conducted in 2003, the National Marine Mammal Laboratory (NMML, 2003) conducted ship-based transect surveys for marine mammals in the Gulf of Alaska. The survey was conducted from the Prince William Sound west along the Alaska Peninsula and included areas around Kodiak Island and into Cook Inlet. Two schools of Pacific white-sided dolphins occurred just off the Kenai Peninsula near Resurrection Bay.

Accidental Oil Spills and Gas Release

Because small refined offshore oil spills dissipate rapidly, and have relatively small volumes when compared to large spills, they would not likely affect Pacific white-sided dolphins. No ERAs were identified for Pacific white-sided dolphins. Since their range includes parts of the OSRA study area, they may occur in some of the ERAs identified for other species (NOAA, 2015b).

For Pacific white-sided dolphins the potential effects of contacting large oil spills are the same as was discussed for Cook Inlet beluga whales, and killer whales.

Effects from the *Deepwater Horizon* spill in the Gulf of Mexico on bottlenose dolphins included increased mortality, stranding, reduced reproductive success, and incidences of disease (i.e., adrenal gland and lung lesions as a contributing cause of death) (Lane et al., 2015; Venn-Watson et al., 2015). Indirect effects from a large spill may result from ingestion of contaminated prey. During the *Deepwater Horizon* oil spill and response period, numerous dolphins were observed swimming through visibly oiled waters and feeding in areas of surface, subsurface, and sediment oiling (Schwacke et al., 2014).

Because of the scarcity of this species in the Lease Area and Cook Inlet, the assumed size of a large spill (5,100 bbls platform or 1,700 bbls pipeline), weathering processes in Cook Inlet, volatilization processes, currents, tides, and the presence of spill cleanup infrastructure, and spill response protocols, the expected level of effects for large spills on Pacific white sided dolphins would be negligible.

Conclusion

Accidental oil spills and gas releases would have a negligible level of effects on Pacific white-sided dolphins.

Sperm Whale (*Physeter macrocephalus*) (Endangered)

The sperm whale is extralimital to the proposed Lease Sale Area; therefore, only large spills could potentially impact this species and only the effects of large accidental spills will be discussed in this section. Male sperm whales have been found to feed in the summer in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Kasuya and Miyashita, 1988; Mizroch and Rice, 2012). Acoustic surveys detected the presence of sperm whales year-round in the Gulf of Alaska though data suggests they are more common in summer than in winter (Mellinger, Stafford, and Fox, 2004).

Accidental Oil Spills and Gas Release

Upon contacting spilled oil, sperm whales may experience inhalation, ingestion, skin and conjunctive tissue irritation, and other health issues similar to other odotocetes discussed in this chapter.

Sperm whales are deep and prolonged divers and can therefore use the entire water column, even in very deep areas (NMFS, 2010b). Most sperm whales are found in deep waters (>3,000 m (9,843 ft)), feeding at depths of 500 to 1000 m (1,640 to 3,280 ft) (where most of their prey is found). As far as it is known, sperm whales feed regularly throughout the year. Sperm whales feed primarily on medium- to large-sized squids but also take substantial quantities of large demersal and mesopelagic sharks, skates, and fishes (Rice, 1989).

The prey base of sperm whales could experience reduction in abundance, distribution, and diversity from contact with oil; thus, the whales could experience injury from consuming contaminated food items or from direct contact with oil fractions. However, the far offshore prey base and the likely dispersion and weatherization oil by the time it reaches far offshore waters makes impacts to prey less likely than to nearshore prey bases.

Sperm whales may be displaced from their normal habitat during a large spill. With respect to oceanic species, preliminary results from tagging studies indicated that sperm whales with home ranges near the *Deepwater Horizon* spill in the Gulf of Mexico stayed in that general region but avoided the most heavily surface-oiled areas (Mate, 2011). Ackleh et al. (2012) recorded sperm whale vocalizations at three sites in the northern Gulf of Mexico before and after the *Deepwater Horizon* spill. Acoustic activity and estimated abundance were analyzed for two of the sites, one 14.5 km (9 mi) and the other 40 km (25 mi) from the *Deepwater Horizon* spill site. There was a decrease in acoustic activity and the number of whales at the nearer site in 2010 as compared to data collected there in 2007, and an increase in activity at the farther site, possibly indicating avoidance of areas around the spill site.

Because of the rarity of this species in the Lease Area and Cook Inlet, the assumed size of a large spill (5,100 bbls platform or 1,700 bbls pipeline), weathering processes in Cook Inlet, volatilization processes, currents, tides, and the presence of spill cleanup infrastructure, and spill response protocols, the expected level of effects for large spills on sperm whales would be negligible.

Conclusion

Accidental oil spills and gas releases would have a negligible level of effects on sperm whales.

North Pacific Right Whale (*Eubalaena japonica)* (Endangered)

The North Pacific right whale is extralimital to the proposed Lease Sale Area; therefore, only large spills could potentially impact this species, and only the effects of large accidental spills will be discussed in this section. North Pacific right whales may be adversely affected by a large spill as described in Section 4.3.6.7. Potential exposure and impacts to this species are discussed below.

Accidental Oil Spills and Gas Release

North Pacific right whale sightings are very rare (notably for the eastern population) and geographically scattered, and most sightings of them in the past 20 years have occurred in the southeast Bering Sea and in the Gulf of Alaska, particularly near Kodiak Island (Shelden et al., 2005; Wade et al., 2011b, as cited in Allen and Angliss, 2014a; Waite, Wynne, and Mellinger, 2003;). The largest number of individuals detected in a single year in this population was 17 in 2004 (Wade et al., 2006) in the Bering Sea. Recent research on the North Pacific right whale suggests there are approximately 30 whales remaining in the eastern population (Wade et al., 2011b).

The highest percent chance that a large spill will contact North Pacific right whale ERAs is described in Section 4.3.6.7. North Pacific right whales are considered vulnerable in these areas from June to September (Appendix A, Table A.1-8). ERA 73 occurs along the eastern extent of Kodiak Island, an area deemed a feeding BIA for North Pacific right whales (Ferguson, Curtis, and Harrison, 2015). The highest densities of these whales in this area occur from June through September (Ivashchenko and Clapham, 2012; Mellinger et al., 2004; Wade et al., 2011a,b; Waite, Wynne, and Mellinger, 2003), with few if any data available from other months.

A large oil spill occurring while North Pacific right whales are present could result in skin contact with the oil, baleen fouling, ingestion of oil, respiratory distress from hydrocarbon vapors, contaminated food sources, and displacement from feeding areas (Geraci, 1990). If a North Pacific right whale encountered spilled oil, baleen hairs might be fouled, which would reduce a whale’s filtration efficiency during feeding.

The area along the south side of the Kenai Peninsula historically may have been inhabited by North Pacific right whales, but there were no definitive sightings of right whales in that area in the 10 years prior to, or following, the Exxon Valdez Oil Spill. None were reported in oil or are reported from surveys conducted in areas near where oil from the Exxon Valdez Oil Spill traveled. The 2013 North Pacific Right Whale Recovery Plan (NMFS, 2013a) lists the relative impact to recovery of North Pacific right whales due to contaminants and pollution as unknown. Due to the rarity of this species obtaining meaningful information from the small number of potential samples would be problematic if not impossible; however the effects analyses for other baleen whales remain consistent regardless of species with regards to oil spill effects. Consequently the effects from oiling on north Pacific right whales would be similar to those described for gray and humpback whales. As with other species there could be a slight decrease in the prey base in some isolated locales; however, the size of a large spill limits the amount of area potentially covered by a large slick. If key feeding areas were contacted by large quantities of spilled oil, the prey species in that area could become oiled or die, possibly resulting in some level of adverse effects to feeding north Pacific right whales. Unlike other marine mammal species in the OSRA area, the small size of this stock effect on any individuals in the stock could, and probably would, have population-level effects.

Because of the absence of this species in the Lease Area and Cook Inlet, their rarity in the Gulf of Alaska, the assumed size of a large spill (5,100 bbl platform or 1,700 bbl pipeline), weathering processes in Cook Inlet, volatilization processes, currents, tides, and the presence of spill cleanup infrastructure, and spill response protocols, the expected level of effects for large spills on North Pacific right whales should be a negligible level of effect.

Conclusion

Accidental oil spills and gas releases would have a negligible level of effects on north Pacific right whales.

Sei Whale (*Balaenoptera borealis*) (Endangered)

The sei whale is extralimital to the proposed Lease Sale Area, occurring in the OSRA area in small numbers. Because sei whales tend to occur in the open ocean, it is unlikely that sei whales would enter the proposed Lease Sale Area; however, their habitat range overlaps with the eastern extent of the OSRA study area (NOAA, 2015b; Appendix A, Map A-1). Consequently small spills would have negligible effect on them. Only large accidental spills could potentially impact this species, and therefore, only the effects of large accidental spills will be discussed in this section.

Accidental Oil Spills and Gas Release

The largest known concentration of sei whales in the Gulf of Alaska occurs during the summer, just east of Portlock Bank (Fiscus et al., 1976). Upon contacting spilled oil, sei whales may experience inhalation, ingestion, and skin and conjunctive tissue irritation with the effects remaining consistent with those described for gray, and humpback whales.

Impacts to affected sei whales from oil contact, contamination, prey reduction, and displacement from and avoidance of habitat are expected to be similar to most mysticetes already discussed in this chapter. Considering their scarcity and limited distribution in the Gulf of Alaska, the effects of the Proposed Action on sei whales would be similar to, but less than those described for humpback whales, fin whales, and minke whales. For these reasons the Proposed Action should have a negligible level of effects on sei whales.

Conclusion

Accidental oil spills and gas releases would have a negligible level of effects on sei whales.

Blue Whale (*Balaenoptera musculus*) (Endangered)

Though the proposed Lease Sale Area is extralimital for blue whales, their range does overlap with the eastern extent of the OSRA study area (NOAA, 2015b; Appendix A, Map A-1). Since blue whales are extralimital to the proposed Lease Sale Area, and very rare in the OSRA area, only large spills could potentially affect them and only the effects of large accidental spills will be discussed in this section.

Accidental Oil Spills and Gas Release

Upon contacting spilled oil, blue whales may experience inhalation, ingestion, and skin and conjunctive tissue irritation. Impacts to affected blue whales from oil contact, contamination, prey reduction, and displacement from and avoidance of habitat are expected to be similar to other mysticetes already discussed in this chapter (excluding right whales). The effects of a large oil spill on blue whales remains the same as what was described for humpback whales.

Considering their scarcity and limited distribution in the Gulf of Alaska, absence from the Lease Area, anatomical similarity to other mysticete whales, effects of the Proposed Action on blue whales would be similar to, but less than those described for humpback whales, fin whales, and minke whales. Consequently, a large oil spill from the Proposed Action would most likely have negligible effects to a negligible level of effects on blue whales.

Conclusion

Accidental oil spills and gas releases would have a negligible level of effects on blue whales.

Beaked Whales

Cuvier's Beaked Whale (Ziphius cavirostris)
Baird's Beaked Whale (Berardius bairdii)
Stejneger's Beaked Whale (Mesoplodon stejnegeri)

There are three beaked whales (Cuvier's beaked whale, Baird's beaked whale, Stejneger's beaked whale) with habitat ranges that are extralimital to the proposed Lease Sale Area but overlap with the OSRA study area (NOAA, 2015b). Since the beaked whales are extralimital to the proposed Lease Sale Area, only effects from large spills could potentially impact them and only the effects of large accidental spills will be discussed in this section. Considering their scarcity and limited distribution in the Gulf of Alaska, the effects of the Proposed Action on beaked whales would be similar to, but less than those described for other odontocetes.

Accidental Oil Spills and Gas Release

No beaked whales are expected to be impacted from a small spill. Because small refined offshore oil spills dissipate rapidly, none should reach the Gulf of Alaska where beaked whales occur. Potential exposure and impacts to this species are discussed here.

Upon contacting spilled oil, beaked whales may experience inhalation, ingestion, skin and conjunctive tissue irritation, adverse effects on their prey base, and other health issues, and the effects would be similar to and consistent with those already described for beluga whales and killer whales.

However, the far offshore prey base and the likely dispersion and weatherization of oil by the time it reaches far offshore waters makes impacts to prey less likely than to nearshore prey bases, especially considering the assumed size of the spill (5,100 bbls platform or 1.700 bbls pipeline), limited spill dispersion, weathering, currents, and the presence of oil spill cleanup infrastructure and protocols.

Most odontocetes, other than sperm whales, do not show a marked avoidance of oil spills, though some studies indicate they can detect it (Geraci, 1990). In captivity, bottlenose dolphins avoided an oiled area (Geraci, St. Aubin, and Reisman, 1983). Geraci (1990) reported that fin whales, humpback whales, dolphins, and other cetaceans have been observed entering oiled areas and behaving normally. These studies, and others cited in other cetacean species large spill discussions, suggest that beaked whales may not to be displaced from or avoid their preferred habitat based on the presence of oil alone, although, they may be displaced by response activities associated with a large spill.

Considering their distribution in the Gulf of Alaska, absence from the Lease Area, anatomical similarity to other odontocete whales, the effects of the Proposed Action on all three species of beaked whales would be similar to, but less than those described for beluga whales, and killer whales. Consequently a large oil spill from the Proposed Action should have a negligible level of effects on beaked whales.

Conclusion

Accidental oil spills and gas releases would have a negligible level of effects on beaked whales.

Pinnipeds

Harbor Seal (*Phoca vitulina*)

Harbor seals occupy a wide variety of habitats in protected and exposed coastlines. They are found throughout Cook Inlet, and coastal areas in the Gulf of Alaska, hauling out on beaches, islands, mudflats, and river mouths to rest, molt, and whelp (USACE, 2012).

Seafloor Disturbance and Habitat Alteration

Given the high tidal energy in the area of consideration, drilling footprints are not expected to support benthic communities where harbor seals sometimes feed (USDOI, MMS, 2003). Construction of a buried pipeline would have localized, minor short-term impacts to pinniped populations (USDOI, MMS, 2003), potentially displacing some seals from pipeline routes. Localized temporary disturbance of seafloor habitats would likely have brief, negligible effects to harbor seals which are highly mobile and can easily shift to other feeding areas (see Chapter 3).

Reduction in the amount or types of prey available to harbor seals may reduce their fitness; however, as described in Section 4.3.5.1, the affected area is limited to result in substantial impacts on harbor seal prey availability of fish and shellfish such that displacement would be brief, and any reductions in fitness would be negligible. For these reasons any seafloor disturbance or habitat alteration would likely have negligible effects on harbor seals.

Noise

Underwater audiograms for phocids suggest they have little hearing sensitivity below 1 kHz, though they can hear underwater sounds at frequencies up to 80 kHz and vocalize at frequencies between 90 Hz and 16 kHz (Richardson et al., 1995; Finneran and Jenkins, 2012; Ciminello et al., 2012; Southall et al., 2007).

Impacts to harbor seals that could arise from the Proposed Action likely would be limited to disturbance or displacement effects caused by a seal's avoidance of airgun noise and vessel presence and noise. Responses to vessel operations would not produce lingering effects among harbor seals. Richardson (1995) observed that pinnipeds in Alaska easily habituate to the presence of large vessels unless approached to within approximately 200 m (656 ft). Cook Inlet receives a substantial amount of vessel traffic, with barging, recreational boating, and other vessel-based activities regularly occurring. This level of vessel activity suggests some level of harbor seal habituation to vessel presence and noise. Overall, there should be negligible to minor effects to harbor seals from underwater noise from Proposed Action activities. The standard suite of mitigation measures required by the NMFS, including PSO presence, start-up, ramp-up, shutdown, and avoidance protocols would keep the impacts at a negligible levels of effect.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have negligible to minor level of effects on harbor seals depending upon approach distances between the aircraft and seals, altitude, noise, and heading. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of pinnipeds to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a,1985b). NMFS imposed mitigations on aircraft altitude (1,000 ft minimum altitude) would mitigate potential impacts, keeping them to a negligible level of effects.

Vessel Traffic

Thiel et al. (1992) found vessels accounted for 75% of the disturbances influencing the spatial distribution of harbor seals. Jansen et al. (2006) reported that harbor seals approached by vessels to 100 m (0.06 mi) were 25 times more likely to enter the water than seals approached at 500 m (0.3 mi). The distances at which harbor deals were disturbed and the level of disturbance (e.g., detection, alarm, harassment) varied by region, vessel type, and vessel speed. Suryan (1995) found the presence or absence of a potential disturbance and the speed of the vessel from a haul-out site affected harbor seal vigilance in the San Juan Islands, Washington. Harbor seals at sites more often disturbed exhibited more vigilance (Suryan, 1995).

Sensitivity of seals to disturbance may depend on previous experience and their breeding or molting status (Jansen et al., 2010). Suryan and Harvey (1999) found increasing levels of tolerance among harbor seals to repeated disturbance by small boats, yet found increased vigilance and disturbance when pups were present. Though that study showed mothers and pups were not more sensitive to cruise ships than other seals, other studies at terrestrial sites noted heightened alertness among pregnant and postpartum females, and a tendency to haul out at the edges of mixed groups or at separate nursery sites (Allen, Ribic, and Kjelmyr, 1988; Jeffries, 1982; Lawson and Renouf, 1985; Newby, 1973; Thompson, 1989).

Harbor seals hauled out on mud flats were documented returning to the water in response to approaching boat traffic (Richardson et al., 1995). Vessels approaching haul-outs slowly may also elicit alert reactions without flushing from the haul-out, and small boats with slow constant speed produced the least noticeable reactions (Richardson et al., 1995). In Alaska harbor seals were documented tolerating fishing vessels with no discernable reactions, and commonly habituation (Johnson et al., 1989).

For these reasons, and considering the location of harbor seal ERAs with respect to the Lease Area, and the standard suite of mitigations NMFS requires such as PSOs presence on vessels, and avoidance protocols, the effects of vessel traffic on harbor seals would be negligible.

Accidental Oil Spills and Gas Release

Because small refined offshore oil spills dissipate rapidly, they would have a negligible level of effects on harbor seals. Harbor seals may be adversely affected by a large spill as described in Section 4.3.6.7, and the potential exposure and impacts to this species are discussed here.

The highest percent chance that a large spill will contact harbor seal ERAs is described in Section 4.3.6.7. The ERAs with a percent chance of a large spill contacting occur in the southern extent of Cook Inlet throughout important harbor seal haul-out areas; the highest percent chance of contact to ERAs occur on the southwestern side (in and near Kamishak Bay), and with relatively lower percent chance of contact to ERAs on the southeastern side (near the southern extent of the Kenai Peninsula).

Much of what is known about the effects of oil on harbor seals stems from research on harbor seals following the 1989 Exxon Valdez Oil Spill in Prince William Sound. Harbor seals can be heavily exposed to oil from an oil spill for two main reasons: (1) the high percent chance of contact to harbor seal ERAs as described in Section 4.3.6.7, and (2) harbor seals showed no avoidance of spilled oil during the Exxon Valdez Oil Spill in Prince William Sound, and were observed swimming in oiled water and surfacing in oil slicks to breathe at the air-water interface where volatile hydrocarbon vapors were present (Frost et al., 1994a, b). Through spring and summer, seals crawled over and rested on oiled rocks and algae at haul-outs. Harbor seals inhabiting central Prince William Sound, including Eleanor Island, the north part of Knight Island, and the west side of Knight Island Passage, became heavily coated with oil. More than 80% of the seals observed in these areas in May 1989 had oil on them (Frost, 1997), with many seals remaining oiled until their molt in August (Frost et al., 1994a,b). Some of the haul-out sites remained oiled through the May/June pupping season, and many pups became oiled shortly after birth (Frost, 1997). In the Bay of Isles and Herring Bay on the north end of Knight Island, 89% to 100% of all seal pups seen were oiled (Lowry et al., 1994).

Effects to pinnipeds from exposure to oil can include mortality, brain and liver lesions, skin irritation and conjunctivitis, increased PAH concentrations in blubber, increased petroleum-related aromatic compounds in bile, and abnormal behavior such as lethargy, disorientation, and unusual tameness (Frost et al., 1997; Loughlin et al., 1994; Spraker et al., 1994).

Studies in Prince William Sound showed harbor seals were temporarily displaced from oiled haul-outs but returned the following year at the same rate as unoiled sites (Frost et al., 1994a,b; Frost, Lowry, and Ver Hoef, 1999). By 1990, there was no longer any difference in the rate of decline between oiled and unoiled sites, and it was concluded that the effects of the oil spill were evident only in population declines of 1989 (Frost et al., 1994a,b). A further analysis of harbor seal population trends and movements in Prince William Sound suggested harbor seals moved away from some oiled haul-outs during the Exxon Valdez Oil Spill (Hoover-Miller et al., 2001), and the original estimate of 300+ harbor seal mortalities may have been overstated, being consistent with an ongoing decline in harbor seal numbers in unoiled areas. Long-term impacts to harbor seals from a large oil spill are not expected. Adjusted counts from

Frost's surveys between 1989 and 1997 (Frost et al., 1994a,b; Frost, Lowry, and Ver Hoef, 1999) showed significant population declines (4.6%), but this may be attributed to a decline that began before the oil spill (Hoover-Miller et al., 2001). Subsequently, the number of seals in the Kodiak Archipelago has been increasing and may be stabilizing from the declines from the previous decades (Blundell et al., 2005; Small, Pendleton, and Pitcher, 2003). In Prince William Sound, indirect effects of oil on harbor seals via exposure to nearshore food resources was considered negligible due to the low likelihood of contamination in prey, combined with large feeding areas relative to the extent of lingering oil (Integral Consulting, 2006).

The size of the large spill in this analysis (5,100 bbl platform or 1,700 bbl pipeline) is at least two or three orders of magnitude less than the assumed size of the Exxon Valdez Oil Spill, which would lower the effects of such a spill below those from the Exxon Valdez Oil Spill. Considering the dispersion of harbor seals in upper and lower Cook Inlet during summer, shift of harbor seals from lower Cook Inlet to Sheilikof Strait feeding areas in fall and winter, weathering data, currents, existing spill response infrastructure, and spill response protocols, and the existing body of knowledge relating to the effects of oil spills on pinnipeds, a large oil spill should have a negligible to minor level of effects on harbor seals, with minor effects occurring inside Cook Inlet and negligible effects outside the inlet.

Conclusion

Seafloor disturbance and habitat alteration, noise, aircraft and vessel traffic, would have a negligible level of effects on harbor seals. The level of effects from accidental oil and gas releases on harbor seals would vary from negligible with a small spill to negligible to minor for a large spill.

Steller Sea Lion (*Eumetopias jubatus*) (Endangered)

Seafloor Disturbance and Habitat Alteration

Any potential impacts of oil and gas development adversely affecting the production and availability of prey to Steller sea lions in this and other critical habitat could adversely modify the habitat. Critical habitat for Steller sea lions occurs outside Cook Inlet and the Lease Area, and is unlikely to experience seafloor disturbance or habitat alteration. Drilling fluids rapidly dilute (USDOI, MMS, 2003) and therefore are not expected to be toxic to planktonic larvae (Rice et al., 1983), and this high dilution factor makes it unlikely drilling rig discharges could adversely affect Steller sea lion prey (NMFS, 1993). Consequently, the localized temporary disturbance of seafloor habitats would likely have a negligible level of effects on Steller sea lions (Section 3.2.3).

Noise

Steller sea lions are expected to have a negligible level of effects from noise associated with the Proposed Action. The greatest potential impacts from noise generally occur at haul-outs and near rookeries, where animals could stampede and injure or abandon pups. With no rookeries near the proposed Lease Sale Area, and designated critical habitat south of the proposed Lease Sale Area, these severe effects are not expected from the Proposed Action.

In-water noise levels thought to elicit a behavioral response from Steller sea lions are >160 dB re 1 µPa for pulse noise and >120 dB re 1µPa for continuous noise; levels high enough to cause damage to their hearing are >190 dB re 1 µPa (Table 4.3.2-13) according to NMFS, though Finneran and Jenkins (2012) and Ciminello et al. (2012) place their impulsive noise TTS and PTS threshold noise levels at 200 and 215 dB respectively (Table 4.3.2-12) and their continuous noise TTS and PTS thresholds at 206 and 220 respectively (Table 4.3.2-13). Because sea lions are skittish, loud, pulsed, frequent, or unfamiliar noises such as from pile driving likely disrupt individuals resting or foraging near the sound source (NMFS, 2005). Many of the SPLs for operational activities (Table 4.2.5-1) are above NMFS's thresholds for Level B harassment; however, the effects on Steller sea lions are expected to be reduced to a negligible level of effects by implementing the standard suite of NMFS IHA mitigation measures that includes PSO presence on vessels and drilling rigs, shutdown, ramp-down, start-up, ramp-up, and avoidance protocols.

Some Steller sea lions utilize areas in the proposed Lease Sale Area, particularly near the mouth of Kamishak Bay and Anchor Point. Those individuals or groups could be disturbed by the Proposed Action; however, Cook Inlet–particularly near Homer, Seldovia, and Anchor Point–experiences a great deal of vessel activity during summer from recreation, commercial fisheries, barging, and other forms of commercial and scientific vessel traffic. Because of the frequent vessel activity within Cook Inlet, Steller sea lions in the area should be at least partially accustomed to vessel presence and noise.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have negligible effects on Steller sea lions. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of pinnipeds to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a,1985b). Because of the location of Steller sea lion haulouts and critical habitat, and considering the 1,000 ft minimum altitude requirement NMFS typically imposes on offshore oil and gas operations in Alaska, aircraft traffic should have a negligible level of effects on Steller sea lions.

Vessel Traffic

Response by Steller sea lions to disturbance will likely depend on season and their stage in the reproductive cycle (Kucey and Trites, 2006). Close approach by humans, boats, or aircraft has caused sea lions to leave haulouts for the water, and caused some animals to use other haul-outs during a study in southeast Alaska (Kucey, 2005). Vessels approaching rookeries and haul-outs at slow speed in a manner where sea lions can observe the approach have less pronounced effects than fast approaches and sudden appearances (NMFS, 2008b). Sea lions may habituate to repeated slow vessel approaches by showing minimal responses. Though low levels of occasional disturbance may have little long-term effects on Steller sea lions, in areas where disturbance are more frequent, haulouts may be permanently abandoned (Kenyon, 1962). Repeated disturbances resulting in abandonment or reduced rookery use by lactating females could negatively affect body condition and survival of pups by interrupting nursing cycles (NMFS, 2008b). Allen and Angliss (2015) observed vessel traffic and tourism had a low impact on the recovery of the Western U.S. Stock of Steller sea lions, and vessel strikes were not identified as a risk to Steller sea lions in the Eastern U.S. Stock. In light of the existing amount of vessel traffic and boating in Cook Inlet and along the Alaskan coast, and the fast responses of Steller sea lions in the water, vessels associated with the Proposed Action are not expected to result in any strikes to Steller sea lions.

Since Steller sea lions were afforded ESA protection in 1990, regulations have been in place to minimize disturbances of animals by people, especially at rookeries (NMFS, 2008b). Steller sea lions are unlikely to be encountered during operations in upper Cook Inlet since they mostly occur outside the inlet, or inside the inlet along the Kenai Peninsula coastline, especially closer to Anchor Point. In specific areas, particularly near the Barren Islands and Cape Douglas, the behavior of Steller sea lions in the water could be modified by noise and other disturbance from seismic surveys and the placement of drilling rigs during exploration and development (USDOI, MMS, 2003). Considering the location of Steller sea lion haulouts and critical habitat areas, their limited distribution inside Cook Inlet, NMFS mitigations such as PSO presence onboard vessels, and avoidance protocols, a negligible level of effects from the Proposed Action is expected for Steller sea lions.

Accidental Oil Spills and Gas Release

Because small refined offshore oil spills dissipate rapidly, they would not likely have measureable effects on Steller sea lions. Steller sea lions could be adversely affected by a large spill as described in Section 4.3.6.7, and only large oil spill impacts to this species will be discussed.

The highest percent chance that a large spill will contact Steller sea lion ERAs is described in Section 4.3.6.7. Steller sea lions are listed as vulnerable year-round in these ERAs (Appendix A, Table A.1-9). All of the ERAs with a percent chance of contact occur within the western DPS Steller sea lion critical habitat (58 *FR* 45269, August 27, 1993), so designated because these areas contain important habitat features such rookeries (e.g., ERAs 31 and 23), major haul-outs, and adjacent foraging areas (e.g., ERAs 24 to 26).

Sea lions contacted by oil could absorb hydrocarbons internally through inhalation, contact and absorption through the skin, or ingestion directly or indirectly by consuming contaminated prey (Engelhardt, 1987; Engelhardt et al., 1977).

Much of what is known about the impacts of a crude oil spill on Steller sea lions was learned from the Exxon Valdez Oil Spill (very large oil spill), though an OCS spill would likely occur much more gradually and be much smaller. Sea lions did not seem to avoid oil during the Exxon Valdez Oil Spill (Calkins et al., 1994), and were sighted swimming in or near oil slicks, while oil was seen near numerous haul-out sites and fouled the rookeries at Seal Rocks and Sugarloaf Island. Steller sea lions may not have the same exposure risk to oil as harbor seals, since observations of sea lions near or in oil following the Exxon Valdez Oil Spill indicate oil did not persist on sea lions as it did on harbor seals (Calkins et al., 1994). Exxon Valdez Oil Spill oil did not persist on most rookeries or haul-out sites either, probably due to their steep slopes and high surf activity. However, some oil accumulated on Seal Rocks and Sugarloaf Island in April 1989. Insignificant amounts of oil were seen at each site during pup counts in late June 1989, but none was seen by 1990.

Mammals have a limited ability to metabolize hydrocarbon contaminants (Addison et al., 1986). All of the sea lions collected in Prince William Sound in October 1989 of the Exxon Valdez Oil Spill had high enough levels of metabolites of aromatic hydrocarbons in their bile to confirm oil exposure and active metabolism at the tissue level. Based on research conducted during and after the Exxon Valdez Oil Spill, none of the data provided conclusive evidence of an effect of the spill on Steller sea lions (Calkins et al., 1994).

Considering the distribution of Steller sea lions, their limited presence in the Lease Area, the expected size of a large spill (5,100 bbls platform or 1,700 bbls pipeline), the limited ability of a large spill to spread, and the existing spill response infrastructure and plans in Lower Cook Inlet, a negligible to minor level of effects is expected from a large oil spill on Steller sea lions.

Conclusion

Seafloor disturbance and habitat alteration, noise, aircraft and vessel traffic, would have a negligible level of effects on Steller sea lions. The level of effects from accidental oil and gas releases on Steller sea lions would be negligible to minor, but only for a large spill.

Northern Fur Seals (*Callorhinus ursinus*)

Northern fur seals are highly migratory and generally found year-round throughout their range. The northward migration of individuals wintering in southern parts of the range begins in March, and from April to mid-June, large numbers are found in Gulf of Alaska coastal waters (Consiglieri et al., 1982). By April, the seal migration reaches the vicinity of Kodiak Island and during the summer months, after adult females and males have migrated through the Aleutian Islands and into the Bering Sea, the majority of fur seals remaining around Kodiak Island are non-breeding individuals. Southward migration from the Pribilof Islands begins in October; by December, fur seals appear off southeast Alaska (USDOI, MMS 2003). Since the northern fur seals mostly occur in deep offshore waters south of Cook Inlet and the Lease Sale Area, only large spills have the potential to affect them and so only large accidental spill effects will be discussed in this section. Considering their distribution in the Gulf of Alaska, the effects of the Proposed Action on northern fur seals less than those described for other pinnipeds.

Accidental Oil Spills and Gas Releases

Because small refined offshore oil spills dissipate rapidly, they would have negligible effect on northern fur seals. Fur seals may be adversely affected by a large spill as described in Section 4.3.6.7, and only the impacts from a large spill to northern fur seals are discussed.

Because the main habitat range of fur seals occurs outside of the proposed Lease Sale Area in the Gulf of Alaska (Consiglieri et al., 1982; Loughlin et al., 1999; Merrick, Loughlin, and Calkins, 1987), their exposure would be limited to any oil reaching the Gulf of Alaska from the source location in the Lease Area or associated pipelines. Though ERAs are not identified for fur seals, they use some of the same areas as the Steller sea lion WDPS, mostly those near Kodiak Island and Shelikof Strait. Fur seals may be particularly prone to oil exposure in these areas during migration through the Gulf of Alaska in April through June and October, though they may be found throughout their range at any time of the year. As with other pinnipeds, adverse impacts to the prey base for northern fur seals would produce adverse effects on individual fur seals; however fur seals generally feed in deeper waters near the continental shelf break and some areas in Sheilikof Strait, while the fish and squid they feed on generally occur in the water column. It is highly unlikely a large spill would contact a sufficient amount of fur seal prey items, so as to measurably affect the population or individual fur seals.

The Wildlife Protection Guidelines for the Pribilof Islands (State of Alaska Division of Spill Prevention and Response, 2010) describe the impacts to fur seals from oil: “The thick pelage of northern fur seals constitutes the principal element of their thermoregulatory mechanism, which restricts heat loss to the surrounding environment. Oiling has been shown to increase the thermal conductance of the pelts 1.4 to 2.0 times. A light oiling (about 30% of the pelt surface) has been shown to result in an approximately 50% greater heat loss when the northern fur seals are immersed in water. The consequence of any loss of insulation will vary between individual animals, and pups are generally the most vulnerable, particularly when the mother is away foraging. The physical condition of animals, such as fat reserves, will also cause variable effects from any oiling, and pups, breeding males just returning to sea, and lactating females would likely have less insulating fat than other segments of the population, making them more susceptible to the effects of oiling.”

Fur seals likely would suffer direct mortality from oiling through a reduced thermo-insulative capacity that would result in hypothermia (Reed et al., 1987; Reiter, 1981). Between 5,000 and 6,000 South American fur seals (*Arctocephalus australis*) and sea lions (*Otaria flavescens*), primarily pups, were documented as being oiled and dying in the M/V *San Jorge* oil spill (estimated at 100,636+ bbls) off Punta del Este in Uruguay in 1997, though little information has been published on the findings (Mearns et al., 1999). As fur seals do not pup in the OSRA study area, impacts to newborn fur seal pups is expected to be negligible; however, fur seal pups may be present in the fall in the OSRA study area. Considering the assumed size of a large spill (5,100 bbls platform or 1,700 bbls pipeline vs. the estimated 100,636+ spill from the M/V San Jorge), the dispersion of the spill constituents, weathering factors, currents, the existence of oil spill response infrastructure and protocols, and habitat use by northern fur seals, a negligible level of effects from large oil spills is expected on northern fur seals.

Conclusion

Accidental oil spills and gas releases would have a negligible level of effects on northern fur seals.

Fissipeds

Northern Sea Otter (Enhydra lutris kenyoni), Southwest (Threatened) and Southcentral Alaska Stock

Seafloor Disturbance and Habitat Alteration

Despite the potential for encountering similar ensnaring debris throughout their range, sea otters are rarely seen entangled in marine debris, perhaps due to behavioral or anatomical differences between them and fur seals (USFWS, 2013a). Entanglement in marine debris currently is not considered a threat to sea otters (USFWS, 2013a). Moreover, the discharge of trash and debris into the marine environment is prohibited, and trash and debris must be returned to shore for proper disposal with municipal and solid waste. As such, the level of effects from trash and debris from the Proposed Action would be negligible.

Non-pelagic trawlers have been shown to affect sea otter food resources through seafloor disturbance (Lance, 2013); the fisheries span a large area and are known to be non-selective in targeting fish species and therefore the seafloor (Lewison et al., 2004; McConnaughey et al., 2000). Organisms commonly eaten by sea otters such as urchins, crabs, and clams, may be damaged by fishery trawling gear (Lance, 2013). Seafloor disturbance from Proposed Action activities would be more localized compared to fishing activities, but potential effects would be similar.

While seafloor habitat disturbance is possible from the Proposed Action, only a small portion of sea otter critical habitat occurs within the proposed Lease Sale Area. Habitat loss was ranked as "low importance" in the recovery plan for the southwest stock of northern sea otters (USFWS, 2013a). No loss or permanent modification of sea otter critical habitat is expected as a result of the Proposed Action, but seafloor-contact stages of development could temporarily, adversely affect some critical habitat and impact local foraging. Sea otters can move relatively long distances in short periods of time; having been observed moving more than 3 km (1.9 mi) daily, and at speeds up to 5.5 km (3.4 mi) per hour (Garshelis and Garshelis, 1984). Therefore, they would be capable of dispersing to unaffected habitat. The Proposed Action would create neither large areas of affected habitat, or barriers to animal dispersal. Localized temporary potential effects from seafloor disturbance and habitat alteration, including the introduction of trash and debris, from the Proposed Action would result in a negligible level of effects to sea otters.

Noise

Sea otters exposed to anthropogenic noise may respond behaviorally (e.g., escape response) or physiologically (e.g., increased heart rate, hormonal stress response) (Atkinson et al., 2009; Fair and Becker, 2000; Goudie and Jones, 2004; Wikelski and Cooke, 2006); however, sea otters generally are resistant to some of the effects of sound; and changes in presence, distribution, and behavior resulting from acoustic stimuli, including airguns, have not been commonly observed (Davis et al., 1988; Ghoul and Reichmuth, 2012a,b; Riedman, 1983, 1984). Sea otters quickly become habituated to some anthropogenic noises (Ghoul and Reichmuth, 2012b). Most of the noises associated with the Proposed Action are within the effective hearing range of sea otters (125 Hz to 32 kHz as per Ghoul and Reichmuth, 2012a,b, 2014; 75 Hz – 75 kHz as per Southall et al., 2007; and 100 Hz- 40 kHz as per Finneran et al. 2012). Only animals in close proximity to sound sources would be expected to show a response to many anthropogenic noises. Additionally, sea otters spend a great deal of time at the surface feeding and grooming (Riedman, 1983, 1984; Wolt et al., 2012), lessening their potential exposure to noises from underwater anthropogenic sound sources is. To date, the USFWS has not determined serious injury, death, or stranding of sea otters can occur from exposure to airgun pulses, even in the case of large airgun arrays, and no physical injuries or fatalities are expected from airgun pulses (USFWS, 2014k). Sea otter responses to vessels may be from the noise of the vessel or the physical presence of the vessel; as such, their responses are discussed in the *Vessel Traffic* section.

Any disturbance to sea otters from anthropogenic noise associated with the Proposed Action is expected to be temporary and localized, leading to a negligible level of effects on sea otters. Mitigation measures that NMFS implements (such as PSOs onboard vessels and platforms, avoidance protocols, minimum 1,500 ft aircraft altitude, ramp-up, ramp down, shutdown), though not intended for sea otters who are managed by the USFWS, are expected to reduce impacts from noise from routine activities to a negligible level of effects.

Aircraft Traffic

During OCS activities, operations would be supported by helicopters. Noise from aircraft is likely to have negligible effects on sea otters. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals; however, minor and short-term behavioral responses of mustelids to helicopters have been documented in several locations, including Alaska (Patenaude et al., 2002; Richardson et al., 1985a,1985b). Though not specifically intended for sea otters, the minimum 1,000 ft aircraft altitude requirement NMFS typically requires for OCS activities would also ensure aircraft presence and noise has a negligible level of effects on sea otters.

Vessel Traffic

Since 2002, the USFWS has undertaken a health and disease study of northern sea otters from all three Alaskan stocks. On average, the USFWS conducts approximately 100 necropsies a year on sea otter carcasses to determine cause of death, disease incidence, and status of general health parameters (USFWS, 2014a). Vessel strike is a recurring cause of death across all three stocks of northern sea otters (USFWS, 2014a). However, it has been determined in most of these cases that although trauma was the ultimate cause of death, there was a contributing factor such as disease or biotoxin exposure, which incapacitated the animal and made it more vulnerable to vessel strike (USFWS, 2014a).

Recreational vessel activities have an effect on marine mammals that spend much of their time on the surface compared to those below the surface (Curland, 1997). Sea otters spend approximately 80% of their time on the surface (Curland, 1997). Because sea otters are slow swimmers compared to other marine mammals, spending much of their time resting at the surface, grooming, and nursing their young, they appear to be highly vulnerable to boating disturbances (USFWS, 2013a). Garshelis and Garshelis (1994) reported heavy vessel traffic in Orca Inlet, Alaska, from May through September from the commercial fishing fleet may have resulted in fewer observations of male sea otter compared to the number of observations made in the same area during winter when vessel traffic was light. Garshelis and Garshelis (1994) believed that seasonal changes in disturbances from vessels were largely responsible for seasonal movements among the male areas, and that vessel traffic also deterred sea otters from using the regions between the various male areas. Curland (1997) reported that sea otters in areas of disturbance by power boats, divers, and kayaks engaged in significantly greater amounts of travel than they did in areas without disturbance (Curland, 1997).

The reactions of sea otters to disturbance (1) are highly variable between seasons, sexes, and populations; and (2) may be modified by experience (reactions often decline in intensity with habituation, and may increase where populations are harassed or hunted) (USFWS, 2013a).

Vessel traffic associated with the Proposed Action could disturb sea otters in some areas. In summer, those impacts should be insignificant compared to the quantity of fishing, tourism, shipping, and other boat traffic in the region (USDOI, MMS, 2003). While male sea otters sometimes habituate to heavy boat traffic, female sea otters, particularly those with pups, are sensitive to disturbance. Furthermore boat traffic could disturb resting patterns of sea otters. Sea otters in Alaska haul out regularly and when they do, they often move into the water when a boat approaches (USDOI, MMS, 2003). Garrott, et al. (1993) reported that sea otters on shore would move into the water with approach of a single small motorboat moving parallel to and 100 m (328 ft) from shore.

Traffic is highest in the eastern portion of Cook Inlet, where sea otter populations are at the highest levels. Despite the studies showing patterns of avoidance cited previously, sea otter populations have thrived in areas with much greater volumes of boat traffic, such as southeast Alaska and British Columbia. For these reasons, disturbance was ranked low as a threat to recovery, and management potential was ranked as moderate due to the vast range of the stock. Disturbance from vessels was ranked as “low importance” in the northern sea otter recovery plan (USFWS, 2013a). For these reasons and considering the offshore location of the Lease Area, vessel traffic from the Proposed Action should have a negligible level of effects on northern sea otters.

Accidental Oil Spills and Gas Release

The 2013 Southwest Stock of the Northern Sea Otter Recovery Plan (USFWS, 2013a) lists oil spills and oiling as a threat and impediment to recovery. Sea otters are particularly vulnerable to contamination by oil (Williams and Davis, 1995). Oil contamination can have immediate and long-term effects on sea otters and population recovery (Peterson et al., 2003). Five characteristics of sea otter biology help explain their extreme vulnerability to oil contamination (USFWS, 2013a):

- Sea otters depend on their fur and the air trapped within it for thermal insulation. Oil destroys the water-repellent nature of the fur and eliminates the air layer, thereby reducing the insulative value by 70% (Williams et al., 1988). The direct result is acute hypothermia.
- Once the fur is fouled, sea otters ingest oil as they groom themselves. Ingested oil damages internal organs, resulting in acute and chronic effects on animal health and survival. Based on a mink model, oral exposure to low doses of oil can lead to changes in hematology, immune function, and reproductive success (Mazet et al., 2001; Schwartz et al., 2004).
- Benthic invertebrates accumulate and store toxic hydrocarbons. Sea otters would ingest hydrocarbons after feeding on contaminated organisms, and some of those contaminants could accumulate in individual sea otters.
- Sea otters are nearshore animals that exhibit strong site fidelity, often remaining in or returning to oiled areas after release. In addition, they often rest in kelp beds, which collect and retain spilled oil.
- Sea otters are often found in single-sex aggregations, numbering into the hundreds. Consequently if large groups of sea otters became oiled, a substantial portion of the reproductive potential of a population could be simultaneously compromised by the effects of oil fouling and toxicity.

Much of what is known about the effects of oil on sea otters stems from research on sea otters following the 1989 Exxon Valdez Oil Spill in Prince William Sound. Sea otters can become heavily exposed to oil and suffer severe effects from a large oil spill for two main reasons: (1) the percent chance of contact to many sea otter ERAs, LSs, and GLSs (Section 4.3.6.7), and (2) the acute loss of sea otters due to the Exxon Valdez Oil Spill, in the range of several thousand sea otters (Ballachey, Bodkin, and DeGange, 1994).

Direct acute effects to sea otters from a large spill include mortality, and lung, liver, and kidney damage (Lipscomb et al., 1993, 1994). Acute effects of the Exxon Valdez Oil Spill included the documented mortality of nearly 1,000 sea otters, with total acute deaths estimated to be as high as several thousand (Ballachey, Bodkin, and DeGange, 1994). Changes in serum enzymes associated with liver damage were documented in wild sea otters in 1992, and again, although to a lesser extent, in 1996 to 1998 (Ballachey et al., 2002, 2003), suggesting that sea otters in the wild may have experienced pathologies similar to those seen in animals dying shortly after the spill. As documented by Short et al. (2004, 2006) and Li and Boufadel (2010), oil has persisted on shorelines and presented a continuing risk of exposure to animals utilizing nearshore areas for at least two decades (Bodkin et al., 2012).

Indirect chronic effects to sea otters from a large oil spill may be caused by (1) sublethal initial exposure to oil causing pathological damage to the otters; (2) continued exposure to hydrocarbons persisting in the environment, directly or indirectly through ingestion of contaminated prey; and (3) altered availability of sea otter prey as a result of the spill (Ballachey, Bodkin, and DeGange, 1994).

Chronic effects to sea otters from exposure to oil have been shown to affect mortality patterns, abundance, and survival rates. By late 1991, three findings indicated that chronic damages were limiting recovery of the sea otter population in Prince William Sound: (1) patterns of mortality were abnormal when compared to pre-spill data (Monson, 1994), (2) surveys showed no increase in abundance (Burn, 1994), and (3) juvenile survival was low in oiled areas of western Prince William Sound (Rotterman and Monnett, 1991).

Possible mechanisms for prolonged oil-related injury to sea otters were substantiated by several studies. Pathologies of the liver and kidney were observed in oiled sea otters recovered dead (Lipscomb et al., 1994), and it is reasonable to assume that similar pathological changes may have occurred in sea otters that were exposed to oil and survived. Residual oil persisted in intertidal (Roberts et al., 1993) and subtidal (O'Clair et al., 1993) areas of Prince William Sound, providing the potential for continued direct exposure of sea otters to oil and possible ingestion through grooming. In addition, particularly high concentrations of oil were found in mussel beds 2 and 3 years after the spill (Babcock et al., 1993). Because mussels are common prey for sea otters, particularly juveniles, the contaminated mussel beds may have been a source of continued indirect exposure to oil.

Studies after the Exxon Valdez Oil Spill also showed that the foraging success of sea otters (in terms of the percentage of successful dives or the mean number of prey items captured per dive) was not affected in the oiled area 2 years after the Exxon Valdez Oil Spill (Doroff and Bodkin, 1994). Prey composition (i.e., clam, mussel, crab) was similar among oiled and non-oiled study sites and to pre-spill data from western Prince William Sound. Adult sea otters foraged primarily in subtidal areas, while juveniles foraged more frequently in the intertidal zone. Tissues of subtidal bivalve prey tested for hydrocarbon content did not differ, regardless of the degree of shoreline oiling. Mussel tissue sampled between 1989 and 1992 from the intertidal areas exhibited hydrocarbon concentrations similar to crude oil in some areas (Babcock et al., 1993). Contamination of mussels and other intertidal prey species may be of concern for juvenile sea otters and for adults focused on the consumption of intertidal prey.

The level of contamination in prey may depend on where the prey is located (e.g., subtidal versus intertidal), and the effects of prey contamination on sea otters may depend on the age class preferences for different prey types (e.g., juvenile sea otters preferring to forage in contaminated intertidal zones, which would be more contaminated compared to subtidal zones in which adult sea otters prefer to forage).

Considerable displacement of sea otters from their habitat may occur as a result of a large spill. The large-scale mortality of sea otters caused displacement of many sea otters from Prince William Sound. Based on comparisons of pre-spill and summer 1989 survey data from Prince William Sound, the 35% decline in shoreline sea otter density within the oiled area suggested a significant first-year effect of the oil spill on the Prince William Sound sea otter population (Burn, 1994).

Further declines in shoreline sea otter density in oiled areas of Prince William Sound between 1989 and 1990 suggested a continuing impact from the oil. However, this decline was mirrored by a decline in shoreline sea otter density within unoiled areas of Prince William Sound, leading Burn (1994) to suggest the possibility of a sound-wide decline in the sea otter population. Abundance estimates of all survey strata combined for July 1989 and July 1990 were not significantly different between oiled and unoiled areas.

As described previously, large mortality events have been associated with very large spill events. The mortality of sea otters numbered in the thousands the first year of the Exxon Valdez Oil Spill, and spill-related mortalities continued for several years. The Prince William Sound population of sea otters was not considered fully recovered from the Exxon Valdez Oil Spill until 2014, 25 years after the spill occurred. Chronic effects to sea otters from exposure to oil have been shown to affect mortality patterns, abundance, and survival rates in the years following the Exxon Valdez Oil Spill.

Unlike the Exxon Valdez Oil Spill, a large spill in the OCS would occur over a period of time, not instantaneously, and a large spill would be several orders of magnitude smaller than the Exxon Valdez Oil Spill. Furthermore because of the slower release of the spill materials, the effects of currents, tides, wind, and other environmental variables should act to disperse the spill such that the entirety of the spill does not affect any one specific area. Instead some of those areas would most likely be contacted by fractions of the greater spill, post weathering.

Another factor to consider is the size of Exxon Valdez Oil Spill has been estimated at a number between 260,000 and 900,000 bbls of crude oil as opposed to the 5,100 bbl offshore and the 1,700 bbl pipeline spill assumption in the OSRA for the Proposed Action (Appx A; p. A-9). Due to the assumed sizes of potential large spills, which are at least two orders of magnitude smaller than Exxon Valdez Oil Spill, the potential effects of a large spill would be much less than what occurred with the Exxon Valdez Oil Spill. These contextual differences between the sizes of the Exxon Valdez Oil Spill and the assumed spills must be considered when contemplating the effects of a small oil spill on sea otters in Lower Cook Inlet. For these reasons a large spill could have a minor to moderate level of effects on both the southcentral and southwest populations of Northern sea otters, while a small spill would likely only afflict the southwest population with a negligible to minor level of effects.

Conclusion

Seafloor disturbance and habitat alteration, noise, and aircraft and vessel traffic, would have a negligible level of effects on northern sea otters. The level of effects from accidental oil and gas releases on northern sea otters would be minor to moderate for a large spill, and negligible to minor for a small spill (southwestern population only).

4.3.6.10. Impact Conclusions

Most IPFs from routine activities in the Proposed Action are expected to have **negligible** to **minor** levels of effects on marine mammals, primarily resulting from anthropogenic noise and vessel traffic that would occur as a result of the Proposed Action. Small spills are expected to have a **negligible** (no to very small effects) level of effects on marine mammal populations due to their limited size, ease of management and cleanup, weathering, and volatilization of spill constituents. A large spill is estimated to have a **moderate** impact on sea otters alone, and a **negligible** level of effects to other marine mammal populations due to oil spill response practices described in Section 4.2.14.3, spill size assumptions, biology and ecology of each marine mammal species, existing mitigation and spill responses, and the lack of effects from historical spills much larger than what was assumed to be most likely large spill associated with the Proposed Action. Oil spill response protocols and the existing spill response infrastructure in Cook Inlet as described in Section 4.2.14.3 are expected to lower the levels of effect in impact conclusions for marine mammals for routine activities and accidental spills by lessening or removing the potential and actual effects inflicted on individual marine mammals.

4.3.7. Terrestrial Mammals

IPFs identified that could impact terrestrial mammal populations are (1) seafloor disturbance and habitat alteration; (2) physical presence, including lights; (3) aircraft traffic and noise; (4) onshore support activities; and (5) accidental oil spills and gas releases (Table 4.2-1). Terrestrial mammal populations that could be affected by these routine activities under the Proposed Action are brown bear, black bear, gray wolf, coyote, red fox, mink, river otter, black-tailed deer, caribou, elk, moose, Dall sheep, mountain goat, and hoary marmot.

4.3.7.1. Seafloor Disturbance and Habitat Alteration

Habitat alteration would take place in terrestrial environments where pipelines from OCS platforms make landfall. Landfall locations are likely to be on the Kenai Peninsula between Homer and Nikiski, with pipeline construction expected to take place between May and September. The area impacted by construction activities related to pipeline landfall would be relatively small in extent and of relatively brief duration. Depending on the exact location of landfall, pipeline construction could impact habitat areas for moose, brown and black bears, river otters, and mink.

Known moose calving areas are found near Homer, and while generally north and northeast of the town, calving areas extend to the shoreline east of Homer. A known moose wintering area is also found along the shoreline east of Homer (ADFG, 1985; Selinger, 2010). The planned timing of pipeline construction should prevent impacts on the moose wintering area as moose likely will have moved to summer feeding areas before the beginning of the construction season. In the event that landfall is within the calving area, moose would be displaced from the immediate vicinity of construction. The known moose calving area near Homer extends landward to within a few miles of the Anchor River (ADFG, 1985). That part of the calving area near the coast is relatively small in extent; therefore, even if construction activities were to take place within this calving area resulting in a displacement of moose landward, the amount of habitat from which moose would be excluded would be relatively minimal. Moose calving areas near Nikiski are several miles inland of the expected landfall location and would not be expected to be impacted by activity related to pipeline construction.

No areas of caribou concentration occur near potential landfall locations in Nikiski or Homer; therefore, this species would not be expected to be impacted by habitat alteration resulting from pipeline construction.

River otters and mink may be impacted by construction activity related to pipeline landfall. These impacts would be localized and brief, likely impacting only a few individuals. Affected individuals likely would be displaced tens to hundreds of meters from the vicinity of construction. This displacement may cause conflicts with neighboring individuals, possibly causing further displacement of neighboring populations. Increased mortality within the construction area also is possible as animals attempt to use habitat exposed to an increased human presence (e.g., construction activities, traffic).

Springtime foraging on beaches by brown and black bears could be impacted by construction related to pipeline landfall. The impact on bears would be less than that experienced by river otters and mink, as bears' home ranges are much larger than those of smaller mammal species. Construction activities would present an increased potential for interactions between bears and humans, including confrontations and traffic accidents. However, as Homer and Nikiski are areas where human populations are concentrated, the increase in bear-human interactions due to construction activity would be expected to be minimal.

As discussed in Section 2.4.5, pipelines installed as part of the Proposed Action will tie in to existing infrastructure; therefore, habitat alteration impacting terrestrial mammals as a result of the Proposed Action is expected to be restricted to construction activities at landfall locations. No additional impacts resulting from construction of additional onshore oil and gas pipelines are expected.

Overall, habitat alteration resulting from pipeline construction, specifically that associated with pipeline landfall, would be expected to have a negligible level of effects on terrestrial mammals inhabiting the area. Impacts primarily would be loss of access to, and use of, limited areas along the shoreline, resulting in displacement of affected individuals to non-impacted areas. Impacts would be greatest among populations of smaller mammals as they typically have smaller home ranges than larger mammals. These impacts would affect few individuals and would take place during the development phase

4.3.7.2. Physical Presence

The physical presence of MODUs, platforms, vessels, and pipelines are not likely to affect terrestrial mammals.

Cook Inlet experiences low to moderate levels of vessel traffic (Eley, 2006). Eley (2012) recorded 480 ship port calls or transits during 2010. Based on 2006 data, Homer, Nikiski, and Anchorage were the ports most visited, with Anchorage accounting for nearly half of the port calls (Eley, 2006). The majority (80%) of large ship operations were made by 15 vessels, a pattern that is expected to continue. Between 1 January 2005 and 15 July 2006, 29% of the vessel traffic in Cook Inlet consisted of gas or liquid petroleum tankers calling primarily at Nikiski (Eley, 2006). Tanker traffic in and around the Nikiski and Drift River terminals is the dominant form of shipping activity in middle Cook Inlet (Eley, 2012). Due to the existing amounts of onshore development in Lower Cook Inlet, the addition of more pipeline and onshore infrastructure should have a negligible level of effects on terrestrial mammals.

4.3.7.3. Aircraft Traffic and Noise

Increased aircraft traffic and noise will occur throughout all phases of operation from seismic surveys through decommissioning, a period of 33 years. An estimated one to three support flights per MODU per day could occur during exploration drilling to transport supplies and personnel. An estimated one to three flights per platform per day could also occur during the production phase. It is expected that helicopter flights supporting drilling activities likely will operate out of Homer or Nikiski. Additional air traffic that would occur under the Proposed Action would not represent a substantial increase in the aircraft traffic at Homer, which averages approximately 132 aircraft operations per day (AirNav.com, 2015a). Although the average daily aircraft operations from Kenai Heliport in Nikiski are not routinely reported, 2 aircraft are based at this field (AirNav.com, 2015b), compared to 93 at Homer (AirNav.com, 2015a). Use of this airport in support of exploration and production would probably represent a substantial increase in the volume of air traffic.

Noise can affect animal physiology and behavior (Radle, 1998), and strong long-lasting noise can have long-term impacts on reproductive success and survival (Kempf and Hueppop, 1997; Radle, 1998). In order to minimize impacts from aircraft-produced sound, all support aircraft would be expected to follow FAA guidance, maintaining an altitude of at least 610 m (2,000 ft) when flying over sensitive areas such as national parks, wildlife refuges, and wilderness areas. All airports considered for potential use in support of exploration and development activities have been in operation for decades, and animals living in proximity to these airports most likely would have become relatively desensitized to the noise produced by aircraft operations.

While support flights from the Kenai Heliport in Nikiski may represent a substantial increase in air traffic from this base, the heliport is located on the coast of the Kenai Peninsula and the duration of flights over land will be limited primarily to takeoff and landing. The Kenai Heliport is located near a moose calving area as well as an area where brown bears concentrate seasonally, and other species occasionally may be present in the area. Impact would be limited to possible startling of animals due to the sound or appearance of a helicopter. The duration of the impact would be brief, lasting a matter of minutes. As most return flights would involve approaching the heliport from platforms or vessels located on the waters of Cook Inlet, animals would be expected to be able to adjust to the increasing volume of an approaching helicopter without being disturbed. Helicopters departing from the heliport would produce sounds associated with start-up and takeoff. These sounds would be produced and increase in volume more rapidly than sounds produced by approaching helicopters. These sounds may briefly startle some animals, but animals that forage routinely in the area would be expected to have become conditioned to the brief bursts of sound.

Kenai Airport is located close to calving grounds used by the Kenai Lowlands Caribou Herd as well as known moose calving areas located in wetlands northeast of the airport. However, air traffic associated with the Proposed Action represents an increase of approximately 5% above normal levels, and animals residing nearby would be expected to have become conditioned to the noise level in this area. Flights originating from Homer Airport would be expected to have similar impacts on nearby moose calving areas as those from Kenai Airport, as the traffic volumes at the two airports are similar and the distances between the airports and moose calving areas are also similar. Flights from the Anchorage area also would begin and end near known moose calving areas, but animals in the vicinity would be expected to be more accustomed to higher volumes of airport noise than those at smaller airports in less densely populated areas.

Helicopter flights in support of oil exploration and production in Cook Inlet would not be expected to impact terrestrial mammal populations substantially in this area. Moose, caribou, and other species of terrestrial mammals inhabiting the areas adjacent to airports would be expected to be conditioned to the increased sound levels in these areas and therefore would be unlikely to be disturbed by the small increase in helicopter traffic. For this reason aircraft traffic associated with the Proposed Action should have negligible effect on those species. Elk, Sitka black-tailed deer, Dall sheep, and mountain goats in the Cook Inlet area inhabit more isolated locations distant from airports and should experience negligible effects due to air traffic or noise associated with the Proposed Action since the aircraft associated with the Proposed Action would have no purpose for visiting those remote onshore areas.

4.3.7.4. Onshore Support Activities

Onshore support activities most likely to affect terrestrial mammals consist primarily of vehicular traffic on area roadways, including the hauling of equipment and supplies to shore bases and hauling of wastes produced during exploration and development phases from barges to onshore disposal facilities, and pipeline installation. Transport of equipment and supplies would occur throughout the expected 40-year period of operations, while the transport of drilling wastes would represent an increase in traffic during the expected 7 years of production drilling. With an average flatbed semitrailer capacity of 24 tons, as many as 1,500 trips may be required to haul drilling waste during the anticipated 7-year development drilling period.

Transport of drilling wastes from shore bases to disposal facilities could increase roadkill of terrestrial mammals due to the increase in vehicular traffic on area roadways. Highway S-490 runs along the coast of the Kenai Peninsula and comes close to calving and summer concentration areas for the Kenai Lowlands Caribou Herd (McDonough, 2011a), and increased vehicular traffic would present an additional hazard to these animals. Highway accidents are the primary cause of mortality directly related to human activity as the hunting season for this herd has been closed since 1994 (ADFG, 2003). Transport along Highway 1 (the Sterling/Seward Highway) would involve passing through the winter range of the KLCH and the ranges of the Killey River Caribou Herd and the Kenai Lowlands Caribou Herd (McDonough, 2011a). Increased traffic along Sterling/Seward Highway between Homer and Nikiski would pass through known moose calving areas and winter concentration areas between Kasilof and Soldotna (ADFG, 1985). Roadkill of moose is high on the western Kenai Peninsula (Selinger, 2010) as well as in the vicinity of Anchorage (Carnahan, 2010). Roadkill also is an important cause of brown bear mortality within the Municipality of Anchorage, with three bears killed by cars in 2008 (Coltrane, 2011a). From 2007 through 2010, seven brown bears were killed in traffic accidents on the Kenai Peninsula (Selinger, 2010). On the north shore of Turnagain Arm between Girdwood and Rainbow, Highway 1 passes through an area frequented by Dall sheep, which are known to cross the highway to access mineral licks on the shoreline (ADFG, 1985; ADNR, 2011). Mountain goats are also found in this area (ADFG, 2016) and could face increased risks from a higher volume of vehicular traffic, though they generally remain in rugged rocky, or alpine areas and not along the roadways. Other species of terrestrial mammals would face the same risks along roadways; however, the degree of impact on local populations of mammals would be less than the potential impact on caribou, moose, Dall sheep, and bears. Elk and Sitka black-tailed deer are not expected to be exposed to any impacts associated with onshore support operations as they inhabit islands remote from areas in which shore support activities would take place.

Approximately 11 hectares (~28 acres) of wetlands, including stream crossings, would be excavated and then backfilled in constructing two buried pipelines. Approximately 61 hectares (~151 acres) of upland would occur in uplands and the entire area of disturbance of 72 hectares (~179 acres) would occur in areas with existing pipelines. Initially after pipeline disturbances, the affected area is returned to an early ecological state that favors herbaceous vegetation and graminoids, often annuals. Upon completion of the construction and installation of the pipelines, the surrounding area would become recolonized by local vegetation or by reclamation plantings to partially return the area to some level of ecological function. Over time, the pipeline corridor would be kept clear of trees and large shrubs to prevent the structural integrity of the pipelines from being compromised by large root systems. Consequently, a small amount of habitat would remain unavailable for some terrestrial mammal species such as porcupines, while other species such as moose and caribou might benefit from the fresh growth of willows and other browse species. The limited size of the disturbed area with pre-existing pipelines, combined with the practice of burying the pipelines, would have a negligible level of effects on terrestrial mammals. The primary risk posed to terrestrial mammals by onshore support activities is the transport of equipment and supplies as well as transport of drilling wastes on area roadways. Loading and unloading equipment, supplies, and drilling wastes would occur at established shore bases and are not expected to have any impacts on terrestrial mammals in the area. While these activities represent an increase in vehicular traffic, it is not on a scale that would be expected to be noticeable above normal traffic levels, and so onshore support activities for the Proposed Action would likely have a negligible level of effects on terrestrial mammals.

4.3.7.5. Accidental Oil Spills and Gas Release

As described in Section 4.2.14, accidental oil spills, including small spills (<1,000 bbl) and large spills (≥1,000 bbl), could occur from fuel transfer accidents, platform fuel tank ruptures, loss of well control of gas, and from platforms, MODUs, and pipelines. The spill size assumptions for large spills involve a 5,100 bbl spill from a platform, or a 1,700 bbl spill from a pipeline. A pipeline spill would contaminate a much smaller area onshore than it would in the OCS.

Small Oil Spills (<1,000 bbl)

The estimated numbers of small spills that could occur under the Proposed Action are summarized and discussed in Section 4.2.14. The majority of the estimated small accidental spills would be <50 bbl, would quickly dissipate, and could affect a very small amount of habitat and relatively few individuals. Small spills ≥50 bbl but <500 bbl would be relatively easy to contain and would affect small areas of habitat and few individuals. Small spills under the Proposed Action include spills of diesel fuel as well as refined and crude oil. Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface, disperse, and weather rapidly. The volatile components of the fuel would evaporate within the first 24 hours, although a small proportion of the heavier fuel components could adhere to PM in the upper portion of the water column and sink. Small spills of crude oil will persist longer in the environment than refined products, but most likely would evaporate or disperse before reaching land and therefore are expected to have a negligible level of effects on terrestrial mammals.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A platform spill would take place farther from shore than most potential pipeline spills, reducing the risk posed to terrestrial environments. An offshore pipeline spill could occur anywhere between the well and landfall, while an onshore oil spill could take place anywhere between landfall and the processing facility. Large spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface, disperse, and weather rapidly. The volatile components of the fuel would evaporate within the first 24 hours, and therefore are not expected to impact terrestrial mammals. Large spills of crude oil will persist longer in the environment and result in greater impacts than spills of refined products. The impact of an oil spill on terrestrial mammal species will depend on the source of the spill, spill location, and the characteristics of the oil once it reaches the shoreline. The OSRA model estimated the percent chance of a large spill contacting various land segments in Cook Inlet and the surrounding region within 3 and 30 days.

Spilled oil weathers naturally through evaporation, dissolution, emulsification, sedimentation, microbial oxidation, and photooxidation (Mendelssohn et al., 2012). Weathering alters the physical and chemical characteristics of oil, degrading it until small quantities of residue such as tarballs are left. Spilled oil may reach shore as fresh oil, which is buoyant and readily disperses across the surface of the water as a thin slick, or as tarballs, or in an intermediate state between the two extremes. Compared to weathered oil, fresh oil more readily penetrates vegetated areas and intertidal sediments. Oil in this state can make toxins more bioavailable to terrestrial mammals as they are absorbed or ingested by food items. Weathering reduces the level of aromatic petroleum hydrocarbons, the most potentially toxic compounds in crude oil, thus freshly spilled (unweathered) oil is the most toxic. PAHs are the most toxic components of crude oil and are persistent in marshes (Mendelssohn et al., 2012). In addition to contaminating vegetation through uptake of toxins into plant tissues, oil penetrating the soil and coming into contact with plant roots and rhizomes can cause plant death. During weathering, oil mixes with water to form a viscous emulsion that is sticky and buoyant, allowing it to coat sediments and vegetation if it reaches shore. Even in a less toxic state due to weathering, the physical coating of vegetation by this sticky emulsion can reduce photosynthesis (Mendelssohn et al., 2012) and may result in plant death. Tarballs generally are less toxic than fresh oil as many of the more volatile compounds have evaporated, and can be avoided easily by terrestrial mammals. However, the strong scent of a newly formed tar ball may serve to attract some animals. Tarballs are very persistent and can travel long distances (NOAA, 2015d).

Studies of the long-term impact of the Exxon Valdez Oil Spill have shown spilled crude oil can become sequestered in some sediments, producing a subsurface reservoir of persistently toxic bioavailable oil (Peterson et al., 2003). Elevated mortality of salmon eggs in oiled streams was observed for at least 4 years after the spill, while tissue contamination of clams was observed until at least 1996. Heavily oiled marshes may be impacted for decades (Hoff, 1995; Mendelssohn et al., 2012). Unlike the Exxon Valdez Oil Spill, a large spill in the OCS would occur over a period of time, not instantaneously. Furthermore because of the slower release of the spill materials, the effects of currents, tides, wind, and other environmental variables should act to disperse the spill such that the entirety of the spill might not affect any one specific LS, GLS, or ERA. Instead some areas would most likely be contacted by fractions of the greater spill, post weathering. An exception would be an onshore pipeline spill. With onshore spills the oil area would remain restricted to a relatively small space, accessible to workers involved in spill response, and have a negligible level of effects on terrestrial mammals.

Another factor to consider is the size of Exxon Valdez Oil Spill has been estimated at a number between 260,000 and 900,000 bbls of crude oil as opposed to the 5,100 bbl offshore and the 1,700 bbl pipeline spill assumption in the OSRA for the Proposed Action. Due to the assumed sizes of potential large spills, which are at least two orders of magnitude smaller than Exxon Valdez Oil Spill, the potential effects of a large spill would be much less than what occurred with the Exxon Valdez Oil Spill. These contextual differences must be considered when analyzing the effects of a large oil spill on terrestrial mammals along Lower Cook Inlet. Moreover there is a history of spills in Cook Inlet that were larger than the 5,100 bbl or 1,700 bbl spill assumptions for the Proposed Action. No documented adverse effects from those historical spills on terrestrial mammals have been noted in the literature to date. Large onshore spills should have a negligible level of effects of terrestrial mammals since the area affected would be relatively small and easily accessed by oil spill response teams.

Terrestrial mammals could be impacted directly by an oil spill reaching the shoreline through physical contact with the oil, inhalation of fumes, ingestion of the oil, or ingestion of contaminated food items. While most studies of the health impacts to animals resulting from oil spills have been conducted on marine mammals such as sea otters (Ballachey, Bodkin, and Monson, 2013; Davis and Williams, 2012), the physiological effects of oiling or consumption of oil would be expected to be similar among all mammalian species. Physical contact can be irritating to the skin of affected mammals, particularly to sensitive membranes around the eyes, nose, mouth, and urogenital tissues (Davis and Williams, 2012). Moderate to heavy oiling can cause affected mammals to become hypothermic as oil rapidly penetrates the fur eliminating the insulating air layer next to the skin (Costa and Kooyman, 1982). While hypothermia may lead directly to mortality due to decreased core body temperature, it can also initiate a suite of debilitating physiological, biochemical, and behavioral changes. Long-term organ damage may result due to vascular system collapse and congestion (Davis and Williams, 2012).

Oiling may result in transdermal absorption, but hydrocarbons also can enter an animal during grooming, as it attempts to remove oil from its fur. Consumption of contaminated food items provides another route for oil to enter the body. Toxic effects of oil contamination can be increased through bioaccumulation, as toxins become more concentrated as they work their way through the food web. Zooplankton exposed to freshly spilled oil may accumulate toxic PAHs, which are then concentrated in fish consuming the zooplankton (Almeda et al., 2013a). Oil taken into the body can quickly lead to widespread contamination, particularly affecting organ systems involved in detoxification and excretion (i.e., liver and kidneys). Biotransformation of toxins takes place in the liver and kidneys as well as the lungs and intestine (Davis and Williams, 2012). Ingested oil may cause ulcers or bleeding. While some toxins are excreted through urine, feces, and expired air, others may accumulate in fatty tissues.

In addition to health effects due to physical contact with or ingestion of spilled oil, terrestrial mammals may be impacted indirectly through loss of habitat or food resources. Vegetation may be destroyed due to heavy oiling, while salmon populations may be reduced due to contamination of sediments in natal streams, and marine mammal carcasses could become oiled which would lead to ingestion by beach-going scavengers such as bears, foxes, coyotes, mustelids, or wolves. Long-term toxic effects on fish may include deformities that increase mortality, in turn decreasing the population (Peterson et al., 2003). Depending on the location and volume of the spill, effects on habitat and food resources may last for years, potentially complicating direct impacts experienced by some terrestrial mammals relying on specific habitat areas and resources.

The potential impact of a large oil spill on terrestrial mammal populations would depend on the location of the origin of the spill, the amount of oil reaching the shoreline, the physical condition of the oil, and the time of year that the spill occurs. A summer spill (April through October) would weather less, allowing more spilled oil to reach shore. A winter spill (November through March) would weather more, reducing the volume of oil reaching shore and altering the physical and chemical properties of that oil, potentially making it less toxic. Considering existing spill response infrastructure and oil spill response protocols in lower Cook Inlet, as well as likely spill sizes, weathering, currents, habitat use, and biological ecology of terrestrial mammals around Cook Inlet, a large oil spill would most likely have a minor level of effects on terrestrial mammals.

Although unlikely, for purposes of analysis, BOEM estimates a well control incident involving a single well could result in the release of 8 MMcf of natural gas in one day. Natural gas condensates would be dispersed very rapidly at a blowout site; thus, it is unlikely that toxic fumes would affect terrestrial mammals or their food sources and probably have negligible effect on them.

Oil-spill Risk Analysis

Terrestrial mammals in Cook Inlet and the surrounding region are represented in the OSRA model by GLSs listed in Table A.1-14 of Appendix A. A summary of the highest percent chance that a large oil spill will contact terrestrial mammal resources within 3 and 30 days during summer and winter is provided in Table 4.3.2-18.

Table 4.3.2-18 Highest Percent Chance of a Large Oil Spill Contacting Terrestrial Mammal Resources[1]

OSRA Feature Type	Highest Percent Chance Contact	Summer		Winter	
		3 days	30 days	3 days	30 days
Grouped Land Segment (GLS)	≥0.5–<6	136 (West Kenai Brown Bears), 137 (West Kenai Moose)	125 (Spring Bear Concentration-1) 137 (West Kenai Moose)	129 (Redoubt Bay Brown Bears), 136 (West Kenai Brown Bears), 137 (West Kenai Moose), 140 (West Kenai Black Bears)	125 (Spring Bear Concentration-1), 129 (Redoubt Bay Brown Bears), 131 (Trading Bay Moose), 136 (West Kenai Brown Bears), 137 (West Kenai Moose), 140 (West Kenai Black Bears), 160 (Kodiak Blacktail Deer)

OSRA Feature Type	Highest Percent Chance Contact	Summer		Winter	
		3 days	30 days	3 days	30 days
	≥6–<25	129 (Redoubt Bay Brown Bears), 140 (West Kenai Black Bears)	129 (Redoubt Bay Brown Bears), 136 (West Kenai Brown Bears), 140 (West Kenai Black Bears)	--	155 (Afognak, Raspberry Winter Elk), 157 (Afognak Blacktail Deer)

Notes -- all percent chances of contact are <0.5.
[1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5 are shown.
[2] Note that the highest percent chance of contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.
Source: Appendix A (Tables A.1-14, A.2-27, A.2-29, A.2-32, A.2-34, A.2-47, A.2-49, A.2-52, and A.2-54). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

During summer, GLS 129 on the western shore of Redoubt Bay at the upper end of Cook Inlet (from the Drift River south to the bight north of Harriet Point including Kalgin Island) and GLS 140 on the western coast of the Kenai Peninsula (from Kachemak south to Port Graham and Nanwalek) are the shoreline areas with the highest percent chance of contact within 3 and 30 days. Within 30 days, GLS 136, which includes the western shore of the Kenai Peninsula from the East Forelands north of Nikiski and south to Halibut Cove at the mouth of Kachemak Bay, may also be contacted. Although less likely, GLS 137 also may be contacted within 3 or 30 days, (including the western shore of the Kenai Peninsula from Kenai south to Ninilchik). GLS 125 (the western shore of Shelikof Strait from Cape Chiniak and Swishak Bay south to Kinak Bay) may be contacted within 30 days.

During winter, GLSs 155 and 157 (on Afognak and Raspberry Islands) have the highest percent chance of contact within 30 days. Although they have a lower percent chance of contact, GLSs 129, 136, 137, and 140 may be contacted within 3 days. Similarly, shorelines of eastern and southwestern Kodiak Island, including GLS 131 (the west coast of Redoubt Bay to near Tyonek), and GLS 160 (from Spruce Island south to Japanese Bay and from Sitkinak and Tugidak Islands north to Sturgeon Head), may be contacted within 30 days.

GLS 129, with the exception of Kalgin Island, includes coastal areas of the Redoubt Bay Critical Habitat Area and provides important foraging areas for brown bears from spring through fall. Approximately 67% of GLS 129 is composed of tidal flats (exposed and sheltered), and approximately 26% is salt or brackish marshes. These habitats provide important high protein forage food for brown bears during the spring and early summer when the animals are recovering from loss of body mass due to hibernation (Smith and Partridge, 2009). Area rivers, particularly the Kustatan River (ADNR, 2009a), support large populations of salmon that return to the rivers to spawn in mid- to late summer; the salmon are an extremely important source of fat and protein for brown bears preparing to return to hibernation (ADFG, 2015a).

GLS 140 consists of approximately 50% tidal flats and 2% salt or brackish marsh. Kachemak Bay State Park makes up a large portion of this area. Tidal flats and marshes provide important food sources during the spring, with summer and fall salmon runs in coastal rivers. Together with the lower densities of brown bears (Selinger, 2011a), these factors make this an important foraging area for black bears.

GLS 136 consists of approximately 38% tidal flats and 7% salt or brackish marsh. This is an important foraging area for brown bears between June and October. During spring, tidal flats and marshes along this coast provide important food sources for brown bears (Suring et al., 1998). Portions of this area also serve as moose (ADNR, 2009a) and caribou (ADFG, 2003) calving grounds during the spring, providing brown bears with additional food sources. Area rivers support summer and fall salmon runs, which brown bears heavily rely on.

GLS 137 is found within GLS 136 and consists of approximately 28% tidal flats and 16% salt or brackish marsh. This area is an important calving ground for moose during the spring, rutting ground in the fall, and winter concentration area (ADFG, 1985; ADNR, 2009a).

GLS 125 consists of approximately 44% tidal flats and 4% salt or brackish marsh. Tidal flats and marshes provide important spring foraging for brown bears recovering from hibernation; salmon runs in area rivers are heavily used during summer and fall.

GLSs 155 and 157 contain large areas of gravel or mixed sand and gravel beaches, ranging from 13% to 63% of the area of each LS composing these GLSs; the beaches provide important wintering areas for black-tailed deer and elk. Woody browse provides the majority of the winter diet for both species (ADFG, 2015a; AKNHP, 2011; Wallmo and Schoen, 1979;), and black-tailed deer also take advantage of accumulations of kelp washed ashore (Veeramachaneni, Amann, and Jacobson, 2006).

GLS 160 contains large areas of gravel or mixed sand and gravel beaches, ranging from 0% to 61% of the area of each LS as well as mud, clay, or rocky shoals (15% to 97%), which provide important wintering areas for black-tailed deer along the eastern and southwest coasts of Kodiak Island (Van Daele and Crye, 2011b).

GLS 131 is dominated by tidal flats which make up 53% to 58% of the shoreline. Salt and brackish marshes are another important landscape type, accounting for 14% to 41% of the shoreline. This is an important wintering area for moose, where they forage on woody browse (ADNR, 2009a).

The estimated large spill volume (1,700 bbl from a pipeline spill of 5,100 bbl from a platform spill) is unlikely to impact the entire area of each GLS under consideration, particularly the GLSs that are estimated to be contacted by a large spill within 30 days (not within 3 days). Impacts from a large spill are likely to be localized, and not affect all resources within the GLS. However, large spill volumes would result in broader area effects.

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. The chance of one or more large spills occurring and contacting various environmental resources is illustrated by examination of the highest combined probabilities. As shown in Appendix A, Table A.2-63, for GLSs relevant to the discussion of impacts on terrestrial mammals, the highest combined probability within 30 days is 1% for GLSs 129, 135, 140, 155, and 157. All other GLSs relevant to the discussion of impacts on terrestrial mammals have combined probabilities of <0.5%. Although the Lake Clark National Park and Preserve (GLS 128) and the AMNWR W Cook Inlet (GLS 127) are not specifically identified as important areas for terrestrial mammals, these GLSs have combined probabilities of 7% and 11% within 30 days, respectively. Important terrestrial mammals' resources in these areas (in particular, brown bears, river otters, and mink) could also be exposed. Impacts to these GLSs from oil spills are discussed in Section 4.3.18, while impacts to fish and shellfish in general are discussed in Section 4.3.5.

4.3.7.6. Impact Conclusions

Generally routine activities associated with the E&D Scenario are not expected to result in substantial effects on terrestrial mammals. Most impacts from routine activities would be localized to the site of the project infrastructure offshore in the proposed Lease Sale Area, geographically distant from terrestrial habitats. Onshore activities would primarily occur in already developed areas and would not result in substantial impacts on terrestrial mammals. Overall, routine activities are expected to result in **negligible** impacts on terrestrial mammals.

Because small spills are expected to evaporate or disperse prior to contacting terrestrial habitats, impacts to terrestrial mammals are expected to be **negligible.** The magnitude and extent of impacts on terrestrial mammals from large spills will be a function of a variety of factors, including (1) the time of year of the spill, (2) the volume of the spill, (3) the type of product spilled, (4) environmental conditions at the time of the spill, (5) the habitats exposed to the spill, and (6) the species exposed to the spill or that utilize the impacted habitats. A large spill could affect habitats along extensive areas of coastline, including important habitats for numerous species of terrestrial mammals. Heavy oiling through direct contact or ingestion of contaminated prey likely would result in mortality, while lightly oiled terrestrial mammals may experience a variety of lethal or sublethal effects. A large spill could also result in the fouling of foraging areas and food resources as well as structural damage to habitat from the cleanup process; however, oil spill clean-up activities would disturb terrestrial mammals from the affected areas. Furthermore it is very unlikely all of the contents from a large spill could contact terrestrial mammal habitat unless there is an onshore pipeline rupture. The constituents of a large spill would be subject to the same volatilization process and weathering as a small spill. Currents and wave actions, along with wind, would likely disperse the spill over an area such that a terrestrial mammal would have very little likelihood of encountering the full spill volume. If an onshore pipeline ruptured, the spill would remain concentrated in a small, highly localized area that should involve a rapid and complete spill response. Overall, impacts on terrestrial mammals from a large spill are expected to be **minor** due to the low potential for adverse impacts from oiling of individuals or habitats. While some terrestrial mammals could become oiled, there should be no effects that could be measured at the population or subpopulation level. The size of a large spill, and the concurrent cleanup activities should act to haze wildlife from impacted areas such that there would be little opportunity for terrestrial mammals to be exposed to the released crude/gas/condensate. Consequently the most likely effects from a large spill on terrestrial mammals should amount to a small amount of oiling on a few animals, and some hazing from clean-up activities until the clean-up process completes. Lastly large spills of around 5,000 bbls and larger have occurred from time to time in Cook inlet (ADEC, 2016b) and have yet to produce any significant adverse effects to terrestrial mammals in the region. Oil spill response practices described in Section 4.2.14.3 should not alter impact conclusions for terrestrial mammals for routine activities or accidental spills.

4.3.8. Birds

Impact-producing factors (IPFs) associated with routine operations and non-routine events as discussed in Section 4.2 that are relevant for birds are (1) drilling discharges; (2) noise; (3) physical presence, including lights; (4) trash and debris (including non-hazardous domestic waste); (5) vessel traffic; (6) aircraft traffic and noise (7) onshore support activities; and (8) accidental oil spills and gas releases (Table 4.2-1).

This section discusses the IPFs, based on the E&D Scenario, and how they can potentially affect birds. Species that are listed as threatened or endangered under the Federal Endangered Species Act (ESA) (16 U.S.C. 1531 *et seq.*) are included in the impact discussions with non-listed species because the routine operations potentially impacting these species are similar to those impacting non-listed species. Potential impacts to birds in the offshore environment from routine operations include the following:

- Behavioral effects and modified prey abundance from structure emplacement and underwater noise, including active acoustic sound sources, drilling and equipment noise, and vessel noise (Boudreau, Courtenay, and Lee, 2009; Lacroix et al., 2003; LGL Ltd., 2012; Payne et al., 2007; Stemp, 1985; Turnpenny and Nedwell, 1994)
- Mortality and energetic costs associated with structure presence and associated light (Black, 2005; Montevecchi, 2006; Montevecchi et al., 1999; Ronconi, Allard, and Taylor, 2015; Russell, 2005; Wiese et al., 2001)
- Behavioral and productivity effects due to disturbance from vessel and OCS helicopter traffic (Bayne, Habib, and Boutin, 2008; Habib, Bayne, and Boutin, 2007)

4.3.8.1. Drilling Discharges

Routine operations potentially affecting birds include operational discharges from exploration, development, production wells, and production platforms. These operational discharges include drilling fluids and cuttings. Well-related discharges will occur in the exploration and development phases of the E&D Scenario. Drilling fluids and cuttings are described in Sections 4.2.2 and 4.2.11, and Table 4.2-2 shows which development phases involve their discharge.

As discussed in Section 4.3.4.2, once discharged, particles of cuttings settle quickly to the seafloor near the discharge point (Neff, 2010; Neff, McKelvie, and Ayers, 2000) and have minor impacts on lower trophic organisms and fish and shellfish resources. Impacts to invertebrates such as those described previously could, in turn, impact birds that are dependent on these prey resources. Many bird species using marine waters of Cook Inlet may feed on both benthic and planktonic invertebrates. Diving ducks and seaducks that may feed on benthic invertebrates while in Cook Inlet include greater scaup, long-tailed duck, and eiders including the ESA-listed population of Steller's eider; these waterfowl also feed on zooplankton, as do phalaropes and seabirds such as storm-petrels.

However, as discussed in Section 4.3.4.2, benthic communities impacted by the discharge of drilling fluids and cuttings recover quickly because sediment grain size and texture altered by the drilling fluids and cuttings rapidly return to pre-discharge conditions (Neff, 2010). The localized and short-term impacts on the benthic communities is expected to result in only negligible to minor impacts to foraging birds, primarily depending on specific area of discharge and accumulation.

4.3.8.2. Noise

Active Acoustic Sound Sources

The E&D Scenario presented in Section 2.4 identifies several types of surveys that would use active acoustic sound sources. The potential for each of these to be used in Cook Inlet is outlined in the E&D Scenario and briefly summarized in Section 4.2.5.1.

Airgun pulses are directional, with the majority of the sound energy directed towards the seafloor and lower levels of sound energy projected laterally from the airgun array; birds could potentially be affected by sounds propagating horizontally away from the array. There is potential for impact from seismic survey activity to seabirds and waterfowl that dive below the water surface and are exposed to underwater noise (Turnpenny and Nedwell, 1994). Phalaropes, gulls, dabbling ducks and certain other species of waterbirds make relatively few or shallow dives only. Many other seabirds (e.g., common murre) and seaducks (e.g., long-tailed duck) can dive to deeper depths (up to 55 m (180 ft) (Piatt and Nettleship, 1985) and 60 m (197 ft) (Ellarson, 1956), respectively); and/or spend more of their foraging time submerged than on the surface. Such diving seabird and waterfowl species could be susceptible to acoustic sounds generated by active acoustic sound sources, as would those species that would dive rather than fly away from a vessel (e.g., grebes, loons, alcids such as murres and puffins, diving ducks, and sea ducks) (Table 3.2.5-1).

Little is currently known about how diving birds use underwater sound for communication, predator avoidance, or other functions, or how they are affected by anthropogenic underwater noise (Dooling and Therrien, 2012). Investigations into the effects of airguns on seabirds by Stemp (1985) and Lacroix et al. (2003) did not observe any mortality to the several species of seabirds studied when exposed to seismic survey noise; furthermore, they did not observe any differences in distribution or abundance of those same species as a result of seismic survey activity. Based on these investigations, and considering the short exposure time and the direction of the sound generated by seismic airgun arrays towards the seafloor as well as the low-frequency equipment used for non-airgun high-resolution geophysical surveys, mortality or life-threatening injury is not expected. Additionally, little disruption of behavioral patterns or other non-injurious effects are expected to occur, resulting in a negligible direct impact for seabirds and waterfowl that are exposed to these sound sources.

During the course of a survey, diving birds are likely to hear the advance of the slow-moving survey vessel and associated airgun noise and move away from the area. A mitigation measure to ramp up (the gradual increase in decibel level as the seismic activities begin) would allow diving birds to hear the start-up of the seismic survey and begin to disperse before any direct impacts can occur.

Active acoustic sound sources could affect fish species (see Section 4.3.5) that are prey items for birds, resulting in decreased prey abundance or altered prey availability. An alteration of prey abundance or distribution could result in additional energetic requirements (i.e., increased foraging) for migrating birds. Birds feeding on these resources might be temporarily displaced and stop feeding, but displacement of prey species is likely to be short-term. Effects on birds are expected to be limited to a small portion of a bird's foraging range for a limited time. Given the continual movement (i.e., brevity of encounter and low chance of encounter in any one location over time) and the limited number of marine seismic surveys (two); the tendency of birds to move away from approaching vessels and apparently out of range of physical harm; and the brief and minor impacts to prey resources, impacts from active acoustic sound sources are expected to have only negligible to minor impacts to birds.

4.3.8.3. Physical Presence, Including Lights

The IPF description presented in Section 4.2.7 identifies structures (e.g., MODUs, platforms), vessels, and pipelines that can attract birds and potential prey items. Table 4.2-2 shows which development phases involve physical presence, and Table 2.4.3-2 provides the numbers of platforms and vessel trips anticipated under the E&D Scenario. All offshore vessels and structures maintain exterior lighting for navigational and aviation safety and special use lighting in accordance with Federal regulations. Artificial lighting can attract and directly or indirectly impact birds (Verheijen, 1985; Gauthreaux and Belser, 2006). The bright lights from occasional gas flaring also may attract and impact birds (Day et al, 2015; Wiese, et. al., 2001).

Many bird species, including passerines, long-tailed ducks, *Somateria* spp. eiders (common eider and king eider), and seabird members of the Procellariidae, Pelecanoididae, Laridae, and Alcidae orders (Table 3.2.5-1), are attracted to offshore rigs and vessels. It is thought that this is due primarily to light attraction at night (Ronconi, Allard, and Taylor, 2015; Black, 2005; Montevecchi, 2006; Montevecchi et al., 1999; Wiese et al., 2001). Some species attracted to the structures are known to become entrapped in nocturnal circulations at the structures, and many of the attracted birds may suffer mortality from collision, exhaustion, or overexposure to heat or incineration by flares (Ellis et al., 2013; Montevecchi, 2006; Ronconi, Allard, and Taylor, 2015; Russell, 2005; USDOI, BOEM, 2015e). Given the potential for collision, mortality is expected as a direct impact to birds from attraction to offshore rigs and vessels. The potential for bird strikes per single vessel or platform is generally not expected to be substantial for species with large stable populations, although it is possible that potential impacts may be more long-lasting and widespread for some species (Erickson, Johnson, and Young, 2005; Merkel, 2010).

Increased avian densities beyond what may be accounted for by light attraction have been documented around offshore platforms and structures, with potential deleterious and beneficial effects (Baillie et al., 2005; Ronconi, Allard, and Taylor, 2015; Russell, 2005; Wiese et al., 2001). Birds may be attracted to offshore structures and vessels for a variety of reasons besides light attraction, including attraction to a foreign structure (Baird, 1990; Tasker et al., 1986), increased foraging opportunities for avian predators such as Peregrine falcon (*Falco peregrinus*) (Ronconi, Allard, And Taylor, 2015, 2015; Russell, 2005; Hamer et al., 2014), roosting sites (Baird, 1990; Russell, 2005; Tasker et al., 1986; van de Laar, 2007), and for use as rest areas during migration or as temporary shelters during inclement weather (Ronconi, Allard, and Taylor, 2015; Russell, 2005; van de Laar, 2007).

Reports of annual bird mortality on oil and gas platforms from collisions, nocturnal circulations, and incineration vary based on avian group, location (especially in relation to migratory pathways), and survey methodology. Russell (2005) estimated an average of 50 collision deaths per platform per year in the Gulf of Mexico. From a partial season of exploratory drilling in the Chukchi Sea, USDOI, BOEM (2015e) estimated that annual bird strikes on drillships and support vessels would occur at a minimum rate of 53 birds per drillship and 11 per associated support vessel (similar to the rate of 11.4 lethal strikes for fishing vessels in southwest Greenland from Merkel (2010)). Baillie et al. (2005) and Ellis et al. (2013) reported fewer than 100 bird mortalities annually in Atlantic Canada related to collisions or strandings on platforms and vessels. A recent study by Hüppop et al. (2016) estimated a minimum annual average of 150 mortalities (not including “a considerable proportion” of corpses that were not found), primarily passerines, at a tall illuminated research platform in the North Sea. Annual bird mortality at oil and gas platforms in the North Sea were estimated as high as 60,000 birds per platform in a worst case scenario model (Bruinzeel, van Belle, and Davids, 2009); the study relies heavily on calculations that are based on assumptions, and maximum rates are related to presence of platforms in main migratory routes (i.e., high exposure to risk). A review of multiple studies by Ronconi, Allard, and Taylor (2015) stated that population-level effects of direct platform mortality may be regional and species-specific, depending on the numbers of platforms in operation and the species that encounter them during migration.

Each spring and fall, birds migrating to and from breeding areas in interior Alaska, the North Slope, and west coast areas of Alaska migrate through Cook Inlet (Day, et al., 2005; USGS, 2014). Species or species groups occurring in Cook Inlet that may be at particular risk of collision in the proposed Lease Sale Area include: passerines which tend to be nocturnal migrants and have demonstrated high relative rates of strikes (USDOI, BOEM, 2015e; Shell Gulf of Mexico Inc., 2012; Bruinzeel, van Belle, and Davids, 2009); greater white-fronted goose, shorebirds, murres and kittiwakes due to their relative abundances; and common eider and species with similar habits of flying fast and low above the water and histories of platform strikes elsewhere (Merkel, 2010). Rusty blackbird is an example of a passerine at risk of striking platforms and vessels in Cook Inlet; it has been among bird strikes recorded during exploratory drilling operations in the Alaska Chukchi Sea in 2012 and 2015 (Shell Gulf of Mexico, Inc., 2012, 2015). Strikes of this species may be expected during similar operations in the proposed Lease Sale Area, particularly given that the Chukchi Sea is considered extralimital for rusty blackbird, while Cook Inlet is well within its breeding range.

Using a rate of 53 strikes/platform/year (USDOI, BOEM, 2015c), minimum strike rates for the three platforms in the E&D Scenario over the 40-year life of the lease could be almost 5,000 birds (assuming Platform 1 in operation 33 years; Platform 2, 31 years; Platform 3, 29 years; see Table 2.4.3-1). Strike events of multiple birds of any one of many species are expected to occur, (e.g., 10 long-tailed ducks and 11 king eiders appeared in each of two separate events on vessels assisting exploratory drilling operations in the Chukchi Sea in a single shortened season (Shell Gulf of Mexico Inc., 2012). These are expected minimum rates, as while some birds found aboard platforms from strikes actually recover, though many more are believed to strike and fall unnoticed in to the sea (Ronconi, Allard, and Taylor, 2015). Hundreds to thousands of additional strikes would be expected for associated vessel traffic (i.e., up to 468 vessel trips a year could occur during development and 312 during the years of production), and potentially, for gas flares; (e.g., the September 14-15, 2013, New Brunswick, Canada Canaport LNG gas flare that killed 7,500 songbirds during migration (CBC News, 2015)). Therefore, strikes of any non-listed species could lead to chronic, long-lasting impacts. For non-listed species that tend to have lower collision risk and are at population levels that are considered stable, it is anticipated that the impacts would range from negligible to minor. Non-listed species that migrate through Cook Inlet with higher collision risks (e.g., passerines, due to light attraction), and/or are known to be facing population declines or be limited in number (rusty blackbird or marbled godwit), could face minor to moderate impacts from strikes should there be relatively chronic direct mortality for years that is relatively large proportional to their declining or small populations.

There are several factors to consider regarding the potential impact of collisions to the listed population of Steller’s eiders. If a few or multiple strikes in the listed population did occur, and/or if strikes occurred chronically over the life of the platform(s), it is possible that such losses could not be recovered within a generation because the population is so low, and such impacts could then be considered long-lasting and severe, even more so for extremely rare Yukon-Kuskokwim Delta breeders. Similar species, i.e., common eider and king eider, are at particular risk of collision, as their collisions, often as flocks, with offshore oil infrastructure and vessels elsewhere in northern waters are well-documented (Merkel, 2010; USDOI, BOEM, 2015e; Bruinzeel, van Belle, and Davids, 2009). Similarities in habits among the eider species, particularly in flying fast and low above the water surface, indicate that Steller's eider are also vulnerable to collisions. The listed population of Steller's eider (Alaska-breeding population) in the proposed Lease Sale Area, however, is considerably smaller than that of the aforementioned other species in areas of their known collisions (i.e., southwest Greenland, Chukchi Sea), where they (common eiders and king eiders) number in the tens to hundreds of thousands: the listed population (i.e., Alaska-breeding population) of Steller's eider in Cook Inlet is believed to be substantially lower even than the estimated total Cook Inlet wintering population of 5,783, likely as low as tens of individuals (see Section 3.2.5.2). Furthermore, the winter distribution of Steller's eider is considered to be generally widespread (USFWS, 2015; Martin et al., 2015), which lowers the risk of impacts in any one portion of the wintering areas, at least per annum (USFWS, 2015). Therefore, even though the habits of all of these eider species may be similar, the opportunity, and ultimately, risk, of collision, is expected to be lower for listed Steller's eiders in Cook Inlet, and no more than a negligible to minor impact from collisions to Steller's eider may be expected.

The hazards of light attraction for birds, particularly during migration, have been well-documented and basic monitoring and mitigation protocols are currently commonly recognized as appropriate strategies for tracking and reducing collision mortalities at artificial structures, including oil and gas platforms. One potential component of a mitigation strategy is monitoring in the form of comprehensive tracking, following pre-determined and scientifically approved protocols, of attractions, collisions, and ultimate fate of grounded birds, to obtain improved and more comprehensive assessments of the impacts associated with platform and associated vessel attraction (Wiese, et. al., 2001; Hatch Associates Limited and Griffiths Muecke Associates, 2000; Baillie, et. al., 2005; Ellis, et. al., 2013). Monitoring also can result in site or condition-specific data that can allow for adaptive management in lighting operations and other potential mitigation strategies. Reduced lighting via platform and vessel design is a widely recognized mitigation strategy. One way to achieve this mitigation is to incorporate reduced and shielded platform and vessel lighting in order to minimize the deleterious impacts of lighting attraction to birds (Ronconi, Allard, and Taylor, 2015; Miles, et. al., 2010). The U.S. Fish and Wildlife Service has recently published recommended guidelines for reducing bird collisions with buildings and building glass, and while these are not specific to oil and gas platforms, the lighting design and operations recommendations (e.g., avoid unnecessary lighting, install motion sensors on all lights, ensure all exterior lighting is "fully shielded" so that light is prevented from being directed skyward, minimize light operation during bird migration periods, etc.) clearly have general applicability (USFWS, 2016). Recent research has also suggested that birds are far less attracted to shorter wavelength (i.e., green and blue) light and that changing the color of artificial lights at structures as an additional mitigation strategy will decrease the number of mortalities among nocturnally migrating birds (Marquenie et. al., 2014; Poot et. al., 2008). Finally, the potential impacts of gas flares may be reduced by ensuring that the height of the end of the flaring boom is higher than the mean flight altitude of low-flying at-risk species, such as has been suggested to be beneficial in the case of the flaring boom at Northstar Island (Day et. al, 2015), and to avoid gas flaring whenever possible during low visibility nights during the height of spring and fall passerine migration season. Adherence to these proposed mitigation measures would be expected to reduce the number of bird strikes, and monitoring would allow for adaptive management (such as revised lighting operations during certain weather patterns or seasons) that would be expected to also reduce bird strikes.

The presence of platforms also has been shown to displace birds from otherwise suitable foraging habitat (Baird, 1990; Ronconi, Allard, and Taylor, 2015) or to disrupt benthic food sources (Section 4.3.4). Attraction to offshore drilling and production structures also increases the risk of exposure to oil from operational discharges for seabirds (Baird, 1990; Montevecchi et al., 1999; Tasker et al., 1986; Wiese et al., 2001). In summary, the effects on non-listed bird populations from the physical presence of platforms (and associated vessel traffic), including lights and gas flaring, is expected to range from negligible to moderate, depending on species. For the listed population of Steller's eiders, these effects could be considered negligible to moderate, due to the extremely limited presence in the proposed Lease Sale Area. As these impacts are primarily caused by collisions due to light attraction, it is expected that they could potentially be mitigated to lower levels by the avoidance of unnecessary lighting, the use of fully shielded light fixtures, and the use of motion sensors wherever human safety allows on platforms and vessels (USFWS, 2016); and monitoring to allow for adaptive management.

4.3.8.4. Trash and Debris (Including Non-Hazardous Domestic Waste)

The IPF description presented in Section 4.2.8 identifies trash and debris as an IPF for birds, and Table 4.2-2 shows which development phases involve trash and debris.

Plastic is found in the surface waters throughout the world's oceans, and it poses a potential hazard to most marine life, including seabirds, through entanglement and ingestion (Derraik, 2002; Laist, 1987). The ingestion of plastic by marine and coastal birds can cause obstruction and ulceration of the gastrointestinal tract, which can result in mortality. In addition, accumulation of plastic in seabirds has been shown to be correlated with the body burden of PCBs, which can cause lowered steroid hormone levels and result in delayed ovulation and other reproductive problems (Pierce et al., 2004). Additional impacts include blockage of gastric enzyme secretion, diminished feeding stimulus, and adults that manage to regurgitate plastic particles could pass them to chicks during feeding (Derraik, 2002). Because the dumping of trash and debris into the ocean is prohibited (see Section 4.2.8), the amount discharged on the OCS as a result of the Proposed Action would be expected to be minimal and result in negligible to minor impact to birds.

Under the Proposed Action, all authorizations for OCS activities may include guidance for trash and debris awareness (proposed ITL No. 7 – Trash and Debris Awareness and Elimination; Section 2.6.3). With this mitigation included, the amount of trash and debris dumped on the OCS would also be expected to be minimal and result in negligible to minor impact to birds.

4.3.8.5. Vessel Traffic

The IPF description presented in Section 4.2.9 describes vessel traffic associated with the Proposed Action, and Table 4.2-2 shows which development phases involve vessel traffic. Disturbance-related impacts to birds from vessel traffic will vary depending on the type, intensity, frequency, duration, and distance to the disturbance source (Blumstein, 2003; Conomy et al., 1998). Effects to birds as a result of attraction to vessel lighting are addressed separately in Section 4.3.8.3. Birds may be affected by vessel traffic in a variety of other manners, including the following:

- Behavioral changes (Agness et al., 2008; Béchet, Giroux, and Gauthier, 2004; Schoen et al., 2013)
- Reduced pairing success (Habib, Bayne, and Boutin, 2007)
- Selection of alternative habitats or prey that may be suboptimal
- Creating barriers to movement or decreasing available habitat (Bayne et al., 2005)
- Decreasing foraging time and efficiency (Schwemmer et al., 2011; Verhulst, Oosterbeek, and Ens, 2001)
- Reduced time spent resting or preening (Tarr et al., 2010)
- Increases in energy expenditures due to flight behavior (versus resting, preening, or foraging) (Ackerman et al., 2004; Agness et al., 2008, 2013; Goss-Custard et al., 2005; Helmers, 1992; Platteeuw and Henkens, 1997)
- Possible decreases in reproductive effort or nest success (Béchet et al., 2004; McGowan and Simons, 2006)

Overall, the literature suggests negative short- and long-term disturbance effects to birds (Carney and Sydeman, 1999; Larkin, Pater, and Tazik, 1996); disturbance-related impacts do not typically result in direct mortality.

Birds disturbed by the presence of an OCS vessel may flee a habitat and may or may not return. Displacement would be short-term in most cases and would not be expected to result in any lasting effects. However, if the displaced birds were occupying active nests, incubating eggs, or feeding/protecting hatchlings, even a short-term absence of the adult bird could result in increased predation of eggs or young, or result in reduced nest success. Additionally, molting birds, particularly sea ducks, would be disturbed by vessel traffic because their ability to move away is restricted. Repeated disturbance to molting birds could lead to reduced foraging success.

Because vessel traffic of varying types exists in Cook Inlet already (see Chapter 5, Section 5.2.8.3), it is likely that most birds in the area are habituated to vessel traffic and may minimally react to passing OCS support and supply vessels. Furthermore, support and supply vessels would use designated coastal navigation corridors where birds would more likely have become habituated to the traffic. Additionally, vessels should adhere to regulations set forth by the USCG for reduced vessel speeds within inland areas or while transiting waterways that have sensitive shoreline resources (e.g., shorebird nesting colonies). Impacts would be limited to the immediate vicinity of the vessel and would be short-term. Wakes from OCS-related vessels are not expected to affect coastal birds and their nests. Compliance with such requirements would minimize potential wake-induced impacts on coastal birds. Vessel traffic, not including light attraction, is expected to have only short-term and/or localized, and therefore **minor**, effects on birds.

4.3.8.6. Aircraft Traffic and Noise

The IPF description presented in Section 4.2.9 describes aircraft traffic associated with the Proposed Action, and Table 4.2-2 shows which development phases involve aircraft traffic. Table 4.2.5-1 provides a summary of the noise produced by aircraft under the Proposed Action.

Noise generated by OCS-related aircraft can disturb birds, including birds that are molting, feeding, resting, and nesting, and can lead to abandonment of preferred habitats. Impacts to birds from aircraft traffic and noise will vary depending on the intensity, frequency, duration, and distance to the disturbance source.

Aircraft that fly too close to densely occupied seabird colonies can potentially cause serious disturbance, although birds' reactions to helicopters and other aircraft are complex, depending on the species involved, colony size, previous exposure levels, and the location, altitude, and number of flights (Hunt, 1985). Low-flying aircraft, especially helicopters, can disturb nesting birds, causing them to leave their nests unattended. Although the adult(s) may be absent from the nest for only a short period of time, eggs and nestlings could potentially be lost either due to exposure or to predators, such as gulls. Birds that nest on offshore rocks and cliffs may be especially vulnerable, because they may accidentally cause eggs or young to fall from cliff ledges if they take flight due to low-flying helicopter disturbance. Helicopters also might disturb roosting birds and birds on the water, such as cormorants, gulls and waterfowl. Helicopter flights especially could be a problem in relatively undisturbed areas. Repeated air-traffic disturbance of concentrations of feeding and molting waterfowl and shorebirds in coastal lagoons and other wetlands may reduce the ability of migratory birds to acquire the energy necessary for successful migration. If such disturbance occurred frequently, migration mortality could potentially increase, and winter survival of affected birds could be reduced. Studies on noise-related impacts to terrestrial birds have shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning (Andersen, Rongstead, and Mytton, 1986; Black et al., 1984; Brown et al., 1999; Delaney et al., 1999; Ellis, and Mindell, 1991; Gladwin, Manci, and Villella, 1988; Komenda-Zehnder, Cevallos, and Bruderer, 2003; Larkin, Pater, and Tazik, 1996).

In many cases, however, the effects of aircraft noise can be negligible, or temporary, with the birds becoming habituated to the noise (Hunt, 1985). For example, thick-belled murre colonies located near an airport where they were subject to high levels of aircraft disturbance did not show a significant decrease in reproductive success compared to other thick billed murres that nested away from the airport (Curry and Murphy, 1995). Nonetheless, unnecessary aircraft and vessel approach of occupied seabird colonies is not generally recommended due to the risk of breeding disturbance (Canadian Wildlife Service, 2013).

Studies of birds other than colonial seabirds that have been exposed to frequent low-level military jet aircraft overflights and simulated mid- to high-altitude sonic booms using mortars, shotguns, and propane cannons have shown aircraft and detonation noise to elicit some short-term behavioral responses, but to have little effect on reproductive success (Ellis and Mindell, 1991). Birds of prey have been reported to habituate to low-altitude helicopter flights and exhibit no effects on their reproductive success (Andersen, Rongstead, and Mytton, 1989; Delaney et al., 1999), and low-altitude (<152 m (500 ft) military training flights have been shown to have negligible effects on the establishment, size, and reproductive success of wading bird colonies in Florida (Black et al., 1984). Multiple studies have indicated that many species of birds will habituate to low-flying aircraft and noise, with negligible effects on reproductive success (Andersen, Rongstead, and Mytton, 1989; Black et al., 1984; Delaney et al., 1999), and Cook Inlet is already subject to extensive helicopter traffic (FAA, 2014a).

Under the Proposed Action, there will be 1 to 3 helicopter flights per day per MODU during exploration drilling (7 to 21 flights per week) and 1 to 3 flights per platform per day (21 to 63 flights per week) during the production phase (Table 2.4.3-2), originating from shore bases in Kenai, Nikiski, Homer, or Anchorage. The potential impacts associated with aircraft traffic will be mitigated by occurring primarily at least 4.8 km (3 mi) away from any coastal, onshore, or offshore nesting area, or on shore bases where it is likely that there are only a few nesting birds. Aircraft traffic and noise can disturb birds at sea, but the effects would be mitigated by being limited to the immediate vicinity of the disturbance and would be very short in duration (a few minutes per flight). Finally, potential impacts of aircraft on seabird colonies may be reduced through adherence with measures identified in proposed ITL 1 (see Ch. 2.6.3.1) concerning vertical separations of aircraft of at least 457-m (1,500-ft) from seabird colonies; Proposed Lease Stipulation No. 3 (Ch. 2.6.1.3) would also reduce impacts via requirements for observer programs that must address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid or minimize disturbance.

Overall, impacts of noise and traffic generated by aircraft are expected to be brief, and birds may return to pre-disturbance behavior within 5 minutes of an overflight (Komenda-Zehnder, Cevallos, and Bruderer, 2003), although birds can be disturbed up to 1 km (0.6 mi) away from an aircraft (Efroymson et al., 2000). On the basis of the studies described, noise generated during normal operations would not be expected to result in long-term disturbance or population-level effects, and is expected to have only transient and localized, and therefore minor effects on birds.

4.3.8.7. Onshore Support Activities

Onshore support activities that could potentially impact birds include the construction of two pipeline landfalls somewhere between Nikiski and Homer and approximately 80km (50mi) each of two parallel pipelines, as described in Section 4.2.12. During the development phase, first an oil and then a gas pipeline (see Table 2.4.3-2) would be constructed in the same corridor. Approximately 11 hectares (~28 acres) of wetlands, including stream crossings, would be excavated and then backfilled to accommodate the construction of the two buried pipelines. Pipeline construction would also disturb approximately 61hectares (~151 acres) of upland. The entire 72 hectares (~179 acres) of construction would be through wetlands and uplands that were previously disturbed by the construction of existing pipelines.

The wetlands and uplands to be disturbed for pipeline construction are expected to be habitat for migrating and nesting birds, particularly waterfowl, shorebirds, and passerines, as discussed in Section

3.2.5. Construction activities in intertidal and other coastal areas in the spring and fall can displace migrating birds from feeding areas during limited stopover and staging times, causing them physiological stress. Construction activities in wetland and upland habitats during the spring and summer breeding season would be expected to displace birds from nesting sites, or directly destroy eggs and flightless chicks of numerous nests, in violation of the Federal Migratory Bird Treaty Act (16 U.S.C. 703-712 et seq.). Adherence to the Land Clearing Timing Guidance for Alaska (USFWS, 2009c), including avoidance of land-clearing and other site-preparation activities during the spring and summer nesting period, would mitigate, i.e., avoid, direct mortality impacts of onshore support activities associated with nesting. Other potential mitigations that would be expected to protect birds from nesting-related mortality and/or long-term loss of migratory stopover or nesting habitat include Section 404 Clean Water Act permit mitigation sequencing processes and permit stipulations (see Section 4.3.9.4). Because the onshore habitat will be backfilled and is expected to be re-established with time, mortality, and disturbance impacts from onshore support activities are expected to be only localized, short-term, and temporary, and therefore minor.

4.3.8.8. Accidental Oil Spills and Gas Release

The impact discussions provided include federally listed threatened or endangered bird species because the non-routine events potentially impacting these species are similar to those that would be expected for non-listed species.

Potential impacts to birds related to accidental spills include the following:

- Direct contact resulting in stress or mortality (Balseiro et al., 2005; Burger and Fry, 1993; Fraser, Russell, and Von Zharen, 2006; Haney, Geiger, and Short 2014a,b; Jenssen, 1994; O'Hara and Morandin, 2010; Ronconi, Allard, and Taylor, 2015; Wiese and Ryan, 2003; Wiese et al., 2001)
- Toxic reactions from inhalation, direct ingestion, or ingestion of contaminated prey (Balseiro et al., 2005; Burger and Fry, 1993)
- Reproductive effects (Golet et al., 2002; Piatt and Andersen, 1996)
- Modified prey abundance (Esler et al., 2002; Golet et al., 2002)
- Damage to and displacement from foraging or molting habitat (Day et al., 1997; Esler et al., 2002; Golet et al., 2002; Lance et al., 2001; Wiens et al., 1996); and
- Disturbance, displacement, and nest failure from cleanup activities (Jenssen, 1994; Andres, 1997)

As shown in Tables 4.2-1 and 4.2-2, accidental spills could affect all resources during all phases of the E&D Scenario (i.e., exploration, development, production, and decommissioning), depending on the spill type, source, and volume.

Accidental events include small (<1,000 bbl) spills and one large (≥1,000 bbl) spill. Magnitude and extent of impacts on birds from such spills will be a function of a variety of factors, including (1) the time of year of the spill, (2) the volume of the spill, (3) the type of product spilled, (4) environmental conditions at the time of the spill, (5) the habitats exposed to the spill, (6) the species exposed to the spill or that utilize the impacted habitats, and (7) the results of response activities. For example, certain species of birds may be more susceptible to contact with spilled oil than others based on their life histories. Diving birds and underwater swimmers such as loons, cormorants, and diving ducks may be the most susceptible to spilled oil because of their relatively long exposure time within the water and at the sea surface (Camphuysen, 2007). Shorebirds and wetland birds also may be susceptible to direct oiling if a spill were to reach the beach intertidal zone where these species forage, or inshore wetland habitats where these species raise young (Section 3.2.5). However, the timing (i.e., if peak periods in bird density overlap temporally with the spill) (Fraser, Russell, and Von Zharen, 2006), location (high- versus low-density area), and environmental conditions (wind conditions, wave action, and distance to shore) may have a greater overall effect on avian mortality than the spill size and fluid type (Byrd, Reynolds, and Flint, 2009; Castège et al., 2007; Wilhelm et al., 2007).

Direct contact with oil can lead to irritation or inflammation of sensitive tissues (e.g., skin, eyes) and fouling of plumage, the primary cause of stress and mortality in oiled birds (Balseiro et al., 2005; Burger and Fry, 1993). Oil causes marked loss of insulation, waterproofing, and buoyancy in the plumage, resulting in death due to hypothermia, exhaustion, starvation, or drowning (Balseiro et al., 2005; Wiese et al., 2001). Oil ingested and inhaled during feeding, grooming, and preening can lead to tissue and organ damage, and can interfere with food detection, predator avoidance, homing of migratory species, disease resistance, growth rates, reproduction, and respiration (Balseiro et al., 2005).

Studies have shown that even small volumes of oil (i.e., oil sheens) are a concern for marine birds because of the potential to compromise thermoregulatory capabilities of diving birds (Fraser, Russell, and Von Zharen, 2006; Jenssen, 1994; O'Hara and Morandin, 2010; Wiese and Ryan, 2003). O'Hara and Morandin (2010) documented measurable oil transfer to feathers with small quantities of oil absorption. Results indicated that even a light coating of hydrocarbons can negatively affect feather microstructure, potentially compromising buoyancy, insulation, and flight characteristics (O'Hara and Morandin, 2010).

Ingested oil causes short- and long-term reproductive failure in birds (Golet et al., 2002; Piatt and Andersen, 1996), including delayed maturation of ovaries, altered hormone levels, thinning of eggshells, reduced egg productivity, reduced survival of embryos and chicks, reduced chick growth, and abandonment of nests by adults (Burger and Fry, 1993; Golet et al., 2002). Reproductive impacts are of particular significance given the short summer period at high northern latitudes and the high energetic investment in egg laying; as a result, many seabirds are capable of raising one chick or clutch per year. Additionally, lightly oiled birds could bring oil contamination or contaminated food to a nest while heavily oiled birds would be unable to return to the nest, resulting in abandonment and starvation of the young.

Food resources used by birds could be displaced from foraging habitats following an oil spill (Esler et al., 2002; Golet et al., 2002). While benthic habitats that support marine invertebrates are not expected to experience severe adverse effects following an oil spill, coastal habitats could experience immediate and prolonged impacts. Similarly, habitat fouling can reduce habitat quality and lead to displacement of affected birds to secondary locations (Day et al., 1997; Esler et al., 2002; Golet et al., 2002; Lance et al., 2001; Wiens et al., 1996). Chapman (1981, 1984) conducted a study of the impact of the 1979 *Ixtoc* spill on shorebirds, and found that oil on the beach caused birds to shift their habitat selection to less productive areas. Displacement of bird species from a portion of preferred feeding grounds will result in additional energetic requirements leading to increased foraging for the migrating birds, potentially making them unable to complete their migration. A study of the *Deepwater Horizon* spill (Corn and Copeland, 2010), showed that, depending on their migration patterns, bird populations as far away as Alaska and northern Canada, Central and South America, or the Caribbean were potentially affected. An evaluation of marine bird population trends following the Exxon Valdez Oil Spill showed that many taxa were not recovering and some taxa showed evidence of increasing effects 9 years after the spill (Lance et al., 2001).

Birds present in or near habitats that have been affected by oil also may be disturbed or displaced during spill cleanup operations (Harwell and Gentile, 2006; Andres, 1997; Jenssen, 1994). Spill cleanup activities may displace birds from nearby habitats, which could result in reduced reproductive success or survival, depending on the nature of those habitats (e.g., nesting, molting, staging). In addition, the duration of cleanup activities may preclude birds from using the area for quite some time.

Small Oil Spills (<1,000 bbl)

The majority of the estimated small accidental spills would be <50 bbl, would quickly dissipate, and could affect a very small amount of habitat and relatively few individuals. Small spills ≥50 bbl but

<500 bbl similarly would be relatively easy to contain and would affect small areas of habitat and few individuals.

Small spills of refined oil such as lube oil, hydraulic oil, gasoline, or diesel fuel would float on the water surface, disperse, and weather rapidly. The volatile components of fuel would evaporate within 24 hours, although a small proportion of the heavier fuel components could adhere to PM in the upper portion of the water column and sink. Small spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products.

An accidental spill could occur offshore or near shore, and the bird species affected and the type of effect would vary depending on the location of the spill (Castège et al., 2007; Wiese and Jones, 2001). If the accident occurred in nearshore waters or in the vicinity of an IBA, shorebirds, waterfowl, and coastal seabirds (Table 3.2.5-1) could be impacted directly or indirectly. Within IBAs, a greater presence of birds is expected. If an oil spill were to occur within or adjacent to an IBA, there would be a greater potential for impact to birds.

If a spill event occurred in offshore waters, oil would float on the water surface where migrating waterfowl and seabirds (e.g., common murre) (Table 3.2.5-1) could be directly and indirectly affected. Impacts would include oiling of plumage and ingestion of oil from preening. Indirect impacts could include oiling of foraging habitats and displacement to secondary locations.

In most areas associated with the Proposed Action, small spills likely would affect relatively small numbers of birds and habitats. Estimated small accidental oil spills could impact birds, and these impacts would be unavoidable. Small spills would be expected to result in short-term impacts to small areas. For isolated small spills, minor impacts are expected to birds. Population-level effects would not be detectable for small accidental spills. Widespread annual or chronic disturbances or habitat effects are not anticipated to accumulate across one year, and localized effects are not anticipated to persist for more than one year.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. The magnitude and severity of impacts would depend on the spill location and size, type of product spilled, and environmental conditions at the time of the spill. Large spills of refined oil such as lube oil, hydraulic oil, gasoline, or diesel fuel would float on the water surface, disperse, and weather rapidly. The volatile components of the fuel would evaporate within 24 hours, although a small proportion of heavier fuel components could adhere to PM in the upper portion of the water column and sink. Large spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products.

A large (≥1,000 bbl) crude oil spill could be difficult to contain and might result in lethal and sublethal effects on relatively large numbers of birds, depending on the season and location. Birds that are not directly oiled could be affected by impacts to nearshore and intertidal lower trophic food resources. For large spills, BOEM conducted an OSRA that provides the areas estimated to be contacted and the percent chance of contact to these areas. A large spill impacting subtidal and intertidal habitats when large numbers of any one or several species of birds are present feeding, staging, molting, or wintering, would result in lethal and sublethal effects that could be widespread due to their migratory nature. Impacts of a large spill could therefore be expected to have a moderate to possibly major effect on birds. If a large oil spill contacted the listed population of Steller's eider or affected its benthic food source, it would be expected to have a moderate to possibly major impact, depending on number of individuals impacted or temporal and areal extent of impact to food resources, due to its small population size.

A large gas release and ensuing explosion and fire would kill any birds in the immediate vicinity during any season. Blowouts of natural gas condensates that did not burn would disperse rapidly at the blowout site; thus, it is unlikely that toxic fumes would affect birds or their food sources, except those very near the blowout source. Bird mortality associated with a blowout could range from a few to hundreds of individuals. However, such a loss would involve several species of birds, with no population-level effects. Only short-term and localized, and therefore, minor, impacts to birds from a gas blowout would be expected.

Oil-spill Risk Analysis

Bird habitat resources in Cook Inlet and the surrounding region are represented in the OSRA model by ERAs, LSs, and GLSs as listed in Table A.1-7 of Appendix A. A summary of the highest percent chance that a large oil spill will contact bird resources within 3 and 30 days during summer and winter is provided in Table 4.3.2-19.

Table 4.3.2-19. Highest Percent Chance of a Large Oil Spill Contacting Bird Resources[1]

OSRA Feature Type	Highest Percent Chance Contact	Summer		Winter	
		3 days	30 days[2]	3 days	30 days[2]
Environmental Resource Area (ERA)	≥0.5–<6	135, 137, 144, 146, 147, 148	111, 112, 119, 122, 130, 132, 133, 134, 137, 149, 151	--	151
	≥6–<25	139, 140	135, 139, 140, 144, 146, 147, 148	137, 149, 144	140, 144
	≥25–<50	136, 138	136, 138	139	137, 139
	≥50	145	145	145, 146	145, 146
Land Segment (LS)	≥0.5–<6	--	87	--	87

Notes: -- all percent chances of contact are <0.5.
[1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5 are shown.
[2] Note that the highest percent chance contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.
Source: Appendix A (Tables A.1-7, A.2-22, A.2-24, A.2-27, A.2-29, A.2-32, A.2-34, A.2-42, A.2-44, A.2-47, A.2-49, A.2-52, and A.2-54). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

As discussed in Section 3.2.5, the bird community in Cook Inlet is complex and includes a large number of species, an abundance of many species, and a variety of life stages and habitat usage that vary with location and time of year. Additionally, there are varying degrees of vulnerability to the effects of an oil spill, depending on season, location, and duration of spill. Hundreds of thousands of birds may be present in the proposed Lease Sale Area during the summer months. Section 3.2.5 and Table 4.3.2-19 show that the Outer Kachemak Bay IBA (ERA 145) has the highest chance (≥50%) of being contacted by a large spill during the summer, followed by the Kamishak Bay IBA (ERA 136), and Tuxedni Island Colony IBA (ERA 138) (≥25% to ≥50%). The Outer Kachemak Bay IBA is an important foraging area year-round for seabirds and sea ducks, an important migration stopover for waterfowl and shorebirds. Birds that utilize the area include Kittlitz's murrelet, marbled murrelet, white-winged scoter, black scoter, and pelagic cormorant. Kamishak Bay IBA is an important habitat for glaucous-winged gulls as well as other seabirds, and the area of highest concentration of molting and wintering Steller's eiders in Cook Inlet (Larned 2006; Rosenberg et. al., 2014). The Tuxedni Island Colony IBA contains a seabird nesting colony hosting black-legged kittiwake, common murre, horned puffin, and glaucous-winged gull. Depending on the source and location of the spill, the percent chance that oil will contact one of these areas after 30 days ranges from ≥25% to ≥50%. Because the percent chance of contact with other areas is low (<25%), birds in these areas are not considered to be at greater than minimal risk. However, the remaining areas listed are IBAs, known bird colonies, or wintering habitat for Steller's eider, or otherwise serve important functions for birds in the area.

Table 4.3.2-19 shows the ERAs that have the highest chance of contact within 30 days; it is estimated that weathering processes over that period would reduce the amount of oil remaining on the sea surface to 24% of the initial volume of the spill in the summer (Appendix A, Table A.1-28).

Based on the large number of birds that occur in the area during the summer months and the likelihood of important bird habitats being contacted, thousands of birds could be impacted as a result of the large oil spill assumed under the Proposed Action. The number of birds that could be lost depends on the size of the spill (1,700 versus 5,100 bbl), the exact timing (e.g., early summer versus late summer), and the movement of the spill (i.e., if the spill remains offshore, fewer birds might be impacted). In addition to direct mortality, a spill during the breeding season could result in failure to breed, reduced hatching success, reduced growth rates, reduced fledgling success, and higher fledgling mortality rates, all of which would contribute to the overall impact of the spill and the time needed for recovery.

Table 4.3.2-19 shows the ERAs with the highest chance of contact by a large oil spill; within 30 days, it is estimated that weathering processes would reduce the amount of oil remaining on the sea surface to 3% of the initial volume of the spill in the winter (Appendix A, Table A.1-28). Outer Kachemak Bay IBA (ERA 145) and the Lower Cook Inlet IBA (ERA 146) have the highest chance (≥50%) of being contacted by a large spill during the winter, followed by the Kamishak Bay Steller's Eider Habitat (ERA 137) and the Tuxedni Bay IBA (ERA 139) (≥25% to <50%). The Outer Kachemak Bay IBA is an important wintering area for seabirds and sea ducks, an important migration stopover for waterfowl and shorebirds, and an important area for foraging seabirds. Birds that utilize the area include Kittlitz's murrelet, marbled murrelet, white-winged scoter, black scoter, and pelagic cormorant. The Lower Cook Inlet IBA provides foraging habitat for the non-breeding glaucous-winged gull. Kamishak Bay Steller's Eider Habitat provides wintering habitat for Steller's eider. The Tuxedni Bay IBA is a fall migration stopover for geese; summer and fall concentration area for scoters; spring migration stopover for long-tailed duck and western sandpiper; black scoter, black oystercatcher, black turnstone; and a molting area for surf scoter and white-winged scoter.

As shown in Appendix A, Table A.2-61, the highest combined probability of one or more large spills occurring and contacting the Outer Kachemak Bay IBA (ERA 145) within 30 days during the life of the Proposed Action is 10%. All other ERAs and LSs associated with this resource had combined probabilities ≤5%.

Although birds, in general, are less abundant during the winter, hundreds to tens of thousands of certain species of birds winter in the area, especially flocks of tens or hundreds of Steller's eiders in each of several nearshore sites in lower Cook Inlet and Shelikof Strait; many other seaduck and seabird species foraging in nearshore and pelagic waters of lower Cook Inlet and Kodiak-Shelikof Strait region; and over 18,000 rock sandpipers using upper Cook Inlet intertidal mudflats (Ruthrauff, Gill, and Tibbitts, 2013) (Section 3.2.5). Based on the more limited distribution of birds during the winter compared with the summer; the lower, but still substantial in certain areas, number of birds in the area during the winter; and the increased weathering estimated to occur during winter, hundreds to thousands of birds could be lost as a result of the large oil spill assumed under the Proposed Action.

Local reduction or contamination of prey resulting from a large oil spill could reduce growth, survival, or reproductive success for some birds; however, many of the birds that likely would be affected by this impact probably would die from contact with the oil itself. If the reduction or contamination of food sources persists long after the spill has dispersed or been cleaned up, impacts to local populations of birds also could persist.

A review of mortality to birds from large and very large oil spills revealed the following:

- In 1969, a well blowout off the coast of California caused a release of 80,000 bbl of oil, and the deaths of thousands of seabirds (McCrary, Panzer, and Pierson, 2003)
- In 1989, the Exxon Valdez Oil Spill in Prince William Sound was estimated to have killed 250,000 birds (Piatt and Andersen, 1996)
- In 2004, a spill of 1,000 bbl of crude oil off the coast of Newfoundland resulted in the death of approximately 4,700 murres and dovekie (Wilhelm et al., 2007); and

- In 2010, the *Deepwater Horizon* event resulted in the discharge of 4.9 million bbl of oil resulting in bird mortality estimates in the hundreds of thousands (Haney et al., 2014a,b)

Therefore, the impacts on birds in the unlikely event of a large oil spill could involve the loss of thousands to possibly tens of thousands of birds, depending on the spill volume (1,700 versus 5,100 bbl), timing (summer versus winter), and movement in relation to seasonal patterns of avian abundance and distribution. Several IBAs that support thousands of migrating shorebirds and waterfowl, and include numerous seabird colonies occur in Cook Inlet. Spills reaching these areas could directly or indirectly expose adults, eggs, young, and food resources. During migration and in winter, significant portions of some bird species concentrate in Cook Inlet. For example, nearly the entire global population of the nominate race of rock sandpiper overwinters in upper Cook Inlet embayments. These species would be vulnerable to population-level impacts from an accidental oil release. An accidental spill reaching wintering areas could impact a large number of Steller's eider that overwinter in coastal areas of Cook Inlet (particularly in the vicinity of the Kachemak and Kamishak Bays). This species congregates in shallow vegetated nearshore habitats, and spills contacting such areas could reduce foraging habitat and food resources locally, and contaminate potential prey.

Offshore spills may expose migrating seabirds and waterfowl as well as pelagic seabirds that forage in areas such as the Barren Islands. The short-tailed albatross does not breed in or near Cook Inlet and is an irregular visitor. Accidental spills would not be expected to affect foraging habitats adversely. Even if short-tailed albatross were exposed, this would not result in population-level impacts on the species. Therefore, offshore spills and subsequent cleanup efforts in Cook Inlet would be unlikely to affect this species.

A large oil spill under the Proposed Action could affect habitats along vast areas of coastline, including a large numbers of birds and important habitats (e.g., nesting colonies, wintering grounds, IBAs). Depending on the timing, duration, size, and location of a large spill, population-level impacts could be incurred by some species. Overall, impacts to birds from a large spill would be moderate to major depending on the timing, location, and environmental conditions affecting the weathering of the oil.

Spill Response Activities

Impacts from oil spills and cleanup operations will be influenced by time of year in Cook Inlet; in particular spill response can be both hindered and aided by the presence of ice (see discussion in Sections 4.3.4.6 and 4.3.5.8). Some spill response activities (see Section 4.2.14.3) are less likely than others to affect birds. Birds are likely to move away from mechanical recovery and *in situ* burning operations in marine waters, similar to moving away from other vessels, and in off-shore waters this is likely to have negligible effects. It is possible that an exception to this may be in heavy ice conditions if a group of birds were sheltering in the same open water lead of a limited area where the response activities were occurring, although impacts to bird populations from such response efforts would still be expected to be short-term and localized. In summary, spill response activities for small spills that are limited to mechanical recovery and in situ burning in the pelagic environment are likely to have negligible to minor effects, depending on ice conditions. For large spills, mechanical recovery and in situ burning limited to pelagic waters may be expected to have short-term and localized, and thus minor effects on birds.

Other spill cleanup activities may affect birds in a variety of ways. Mechanical recovery, *in situ* burning, or other spill response activities that take place in nearshore, intertidal, or coastal environments may displace birds from important habitats in the immediate or adjacent area, which could result in reduced reproductive success or survival, depending on the nature of those habitats (e.g., nesting, molting, staging). In addition, the duration of cleanup activities may preclude birds from using the area for an entire season (i.e., length of stay in the vicinity of the proposed Lease Sale Area), which could in turn potentially disrupt a year's productivity. The Prince William Sound population of the long-lived shorebird, black oystercatcher, however, recovered quickly after widespread disruption to a breeding season (including nest destruction) from mechanical and other physical means of oil spill recovery onshore (Andres, 1993). There may be a time lag in benthic prey productivity but most disturbed intertidal and subtidal invertebrate communities would eventually recover (USFWS, 2015), and mechanical and physical means of response are expected to have only minor impacts to invertebrate and fish (Sections 4.3.4.6 and 4.3.5.8), which could be important food resources for birds. In summary, oil spill response activities for large spills that include mechanical recovery and other physical presence and in situ burning, that occur in the nearshore, intertidal, or coastal environments, would be expected to have minor impacts because the effects would likely be short-term and generally localized for one spill not exceeding 5,100 bbl.

Chemical dispersants may also have some effects on birds. Chemical dispersants do not remove oil from the water; they break it into much smaller particles in water, making it less likely that a bird will be coated by oil. Chemical dispersants themselves, however, may have some toxicity for birds, reducing ability to shed water (Jenssen and Ekker, 1991; Jenssen 1994; Stephenson and Andrews, 1997), or affecting development of waterfowl embryos (Finch et al., 2012). Molting birds can be more vulnerable to feather wetting (Stephenson, 1997), while having elevated energy demands since synthesizing new feathers (USFWS, 2015). Chemical dispersants can also have a minor, in the case of small spills, to moderate, in the case of large spills, impact on invertebrates or fish (Sections 4.3.4.6 and 4.3.5.8), which may in turn impact those birds that may be depending on those food resources. The use of chemical dispersants is expected to have minor impacts to non-listed birds, however, because overall any impacts from response to small or large spills should be short-term and/or localized, and less than severe. Regarding the listed population of Steller's eider, if large numbers of molting and flightless birds are encountered as in Kamishak Bay, fewer than tens of them would belong to the listed population. Should listed Steller's eiders be dependent on benthic shellfish resources there that become contaminated by chemical dispersants, and/or if listed eiders are directly impacted by chemical dispersants, minor impacts could result. Minor impacts would be expected if large numbers of molting birds encountered dispersants and food resources were impacted in such a way to reduce fitness of birds over time, because so few of the Steller's eiders present in any one area will actually be from the listed population.

In summary, it is expected that oil spill response activities for small and large spills will have minor impacts to non-listed birds, and listed Steller's eider.

4.3.8.9. Impact Conclusions

The nature and magnitude of effects on birds of routine operations in the proposed Lease Sale Area would depend on the specific locations of the infrastructure development as well as the species exposed to the operation. For routine activities, the primary effects would be the disturbance of birds (and their normal behaviors) by noise from a variety of sources, and injury or mortality as a result of potential attraction and collisions with infrastructure and support vessels.

In general, routine operations associated with the E&D Scenario are not expected to result in population-level effects on birds species. Most impacts from routine operations would be localized to the site of the project infrastructure or along support vessel and aircraft routes, would be short-term or transient for most operations, and would likely affect relatively few individuals or habitats. Birds tend to habituate to human activities and noise, especially in areas like Cook Inlet, where local bird populations are regularly exposed to noise, construction, and vessel traffic associated with commercial and recreational activities. In most cases, noises disturbing birds would be short-term or transient, and would be expected to have negligible impacts on birds. OCS oil and gas activities could result in short-term avoidance or abandonment of habitats in the immediate area of the activity. However, because of the relatively small amount of habitat that could be disturbed, habitat disturbance is expected to have negligible impacts. Additionally, with the application of mitigation measures, lessees and their contractors will be cognizant of the recommendations contained within proposed applicable ITLs (Section 2.6.3), such as aircraft and vessels maintaining a >1.8-km (1-mi) horizontal distance and aircraft maintain at least a 457-m (1,500-ft) vertical distance above known or observed wildlife concentration areas such as seabird colonies. Recognition and subsequent adherence to proposed applicable ITL recommendations will limit the behavioral disturbance of most birds found in or near the proposed Lease Sale Area.

The greatest potential direct impact to birds from routine operations is anticipated to be from mortality of birds colliding with or incinerated by offshore platforms and vessels providing support services to offshore platforms. Such collisions are anticipated to affect individual birds and small flocks of birds on an annual basis and result in potentially **minor** to **moderate** impacts to a few non-listed species and populations and **negligible** to **minor** impacts to the listed population of Steller's eider. With mitigation in the form of reduced and shielded lighting, the impacts of all routine operations of the Proposed Action on birds may be expected to be reduced and possibly reach **minor** levels.

Accidental oil spill events include small (<1,000 bbl) spills, and one large (≥1,000) spill stemming from fuel transfer accidents, platform fuel tank ruptures, and well blowouts of gas from platforms, MODUs, and pipelines could occur. The magnitude and extent of impacts on birds from such spills will be a function of a variety of factors, including (1) the time of year of the spill, (2) the volume of the spill, (3) the type of product spilled, (4) environmental conditions at the time of the spill, (5) the habitats exposed to the spill, (6) the species exposed to the spill or that utilize the impacted habitats, and (7) the results of response activities. While most accidental spills would be small and would have relatively small impacts on birds, large spills that reach coastal areas could have more persistent impacts, impact a greater number of birds and species, and require remediation. A large spill could affect habitats along extensive areas of coastline, including large numbers of birds and important habitats (e.g., nesting colonies, wintering grounds). Heavy oiling through direct contact with a spill likely would result in mortality, while lightly oiled birds may experience a variety of lethal or sublethal effects. A large spill could result in the fouling of foraging areas and food resources for birds as well as mechanical damage to habitat during the cleanup process. Overall, impacts to birds from small spills are expected to be **minor** and impacts to birds from large spills are expected to be moderate to **major**.

4.3.9. Coastal and Estuarine Habitats

As outlined in Table 4.2-1, IPFs that could impact coastal and estuarine habitats are (1) other operational discharges, (2) trash and debris (including non-hazardous domestic waste), (3) vessel traffic, (4) onshore support activities, and (5) accidental oil spills and gas releases.

Cook Inlet encompasses a wide range of coastal habitats along and across shore from the high to low intertidal zones, including supratidal, intertidal, and subtidal communities; rocky intertidal communities, including bedrock and boulder shores; mud flats and beaches; and subtidal communities, encompassing kelp forests and eelgrass beds. Also, a diverse variety of wetlands are found along the Cook Inlet coast (e.g., freshwater emergent wetlands, coastal bays, coastal ponds and lakes, tidal marshes, salt marshes, tidal streams).

In the following analysis, potential effects on coastal and estuarine habitats are discussed per IPF as a whole. In some cases, published literature permits discussion of a specific habitat type. IPFs are organized by phase of oil and gas activity (i.e., exploration, development, production). IPFs that occur during multiple phases are addressed in the phase in which they first appear; these discussions are then referenced where applicable. Activities presented in the E&D Scenario are predicted to utilize existing onshore infrastructure. Therefore, it is assumed that the E&D Scenario will result in little ground disturbance that could affect vegetation and wetlands.

The exposed coastlines of Cook Inlet have predominantly low-energy muddy shores that generally are of low vulnerability (see Appendix A, Table A.1-2). Other shorelines in Cook Inlet consist of sandy beaches, mud and sand flats, and small areas of salt marsh.

4.3.9.1. Other Operational Discharges

Other operational discharges such as desalination unit brine, domestic wastewater, and gray water, as described in Section 4.2.3, would be treated as required by the NPDES permit for operations offshore and would not contribute to impacts on coastal and estuarine habitats. Concrete, steel, or non-treated wood are relatively inert and generally do not leach contaminants into the water.

4.3.9.2. Trash and Debris (Including Non-Hazardous Domestic Waste)

Trash and debris can affect biota in coastal and estuarine habitats directly through consumption or entanglement, which can cause infection and death (Cottingham, 1988). Debris can be transported by currents to other areas, where it can become snagged and attached to benthic habitat, damaging sensitive reef habitat. Plastics are an especially persistent form of solid waste that tend to concentrate along coastal areas because they float on the surface and are transported by ocean currents (Milliken and Lee, 1990).

Most floating debris found in estuaries consists of improperly discarded waste material and litter from land-based sources and boats. World-wide, the human coastal population is increasing rapidly in size and is accessing estuarine environments more frequently, increasing the volume of floating debris in estuaries. Plastics make up the bulk of all litter identified in some systems. Up to 95% of the litter collected at some sites in the Bay of Biscay of France and Spain and an average of 80% of the debris identified in Seine Bay in France consist of plastics (Goldberg, 1994). Among the wide variety of debris types, plastics are most dangerous to fauna of estuarine environments and pose a threat to birds, marine mammals, and other organisms that ingest or become entangled in them (Goldberg, 1994; Kennish, 1997). In addition, plastics essentially do not degrade in the environment and therefore are a long-term pollution hazard. While fauna using coastal and estuarine habitat could be negatively and directly impacted by trash and debris, the accumulation of trash and debris in Cook Inlet typically is a temporary impact by accumulation of trash and debris that shades the coastal and estuarine habitats. Shading reduces the productivity of wetland plants.

NOAA qualitatively surveyed Cook Inlet in 2014 as part of a larger Gulf of Alaska survey for marine debris; the survey information is available in the Environmental Response Management Application Arctic (ERMA). Both east and west sides of Cook Inlet in the vicinity of the proposed Lease Sale Area were classified as having light to no debris. Queries of ERMA's (AK JTMD Survey Frames 2014 and 2012) and use of metadata and accompanying aerial photographs identified most of the survey results as coastal debris and trash with a rating of light concentration of debris to no debris found in the images from aerial photographs. Within ERMA's metadata on individual locations "debris" is classified as natural materials, mostly sticks and branches typically found in the "trashline" along the high tideline. Logs were the most numerous category appearing in the aerial photographs, and separate from debris. Human activities in the survey were build structures, vehicle tracks. Logs were listed separately and were the most commonly encountered item in the survey. Plastic wastes were among the least commonly encountered among trash and debris. The Center for Alaskan Coastal Studies (CACS) in Homer, AK, has run an annual citizen science debris cleanup and removal operation, called the Coastwalk, in Kachemak Bay and extends northwestward to the Anchor River; dating back into the 1980's (Peter Murphy, NOAA personal communication). Given the intensive use of the eastern and western coast and the relatively sparse amount of trash and debris along Cook Inlet shores, adjacent to the proposed Lease Sale Area, individuals frequently, it is likely individuals and other possible groups may also police the coast. Eelgrass beds are vulnerable to increased turbidity, sediment disturbances, and eutrophication that could occur as a result of development activities; in turn, these could promote growth of epiphytic algae on eelgrass, decrease eelgrass photosynthesis and growth, and smother or uproot eelgrass (ADFG, 2006). There are no eelgrass beds in the proposed Lease Sale Area or in adjacent waters.

The discharge of trash and debris is prohibited unless it is passed through a comminutor and can pass through a 25-mm (1-in.) mesh screen (33 CFR 151.51 through 151.77). Discharge of plastic is prohibited regardless of size. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste.

Under the Proposed Action, all authorizations for OCS activities would include guidance for trash and debris awareness (ITL No. 7 – Trash and Debris Awareness and Elimination; Section 2.6.3). Therefore, the amount of trash and debris dumped on the OCS would be expected to be minimal. Accidental loss of trash and debris is anticipated, some of which would float on the water surface resulting in negligible impacts to coastal and estuarine habitats.

4.3.9.3. Vessel Traffic

Oil and gas development activities that may affect the coastal zone are many and varied. Development and industrial activities such as vessel traffic within estuaries can result in habitat loss or degradation, environmental contamination, shoreline erosion, the resuspension of sequestered carbon, and the invasion of alien species (Robb, 2014). Accidental vessel groundings can smother or crush shellfish, scour vegetation, and disturb substrates (Nightingale and Simenstad, 2001). In addition, moored vessels contacting the bottom during low tides can cause the benthic habitat in the area of the mooring to be unavailable for fish and other marine biota. Vessels that contact the bottom can scour the substrate and result in permanent alteration or loss of benthic habitats such as eelgrass. Motorized watercraft adversely affect estuarine systems by increasing erosion and sediment resuspension as well as by remobilizing sediment-bound nutrients and chemical contaminants via propeller and pressure wave effects (Kennish, 2002).

Because materials for offshore fields are usually supplied by vessels, there may be increased need for navigation channels and associated alterations of coastal habitats (Boesch et al., 2005). However, as proposed in the E&D Scenario, onshore space and navigation demands will be met with existing infrastructure. Long-term adverse changes to the shore and harbors due to the vessel traffic are unlikely and overall impacts to coastal and estuarine habitat would be minor.

4.3.9.4. Onshore Support Activities

Onshore pipeline construction would require permitting by the Federal Energy Regulatory Commission and U.S. Department of Transportation, including additional, site-specific environmental review. Also, authorization would likely be required to for Anadromous Fish Stream crossings from the State of Alaska and the U.S. Army Corps of Engineers (USACE) for pipelines crossings of wetlands and other waters of the U.S. Since the construction of pipelines is not water dependent, the USACE would require mitigation to further minimize construction impacts and wetland losses.

The E&D Scenario assumes the construction of one new oil pipeline and one new gas pipeline from the initial platform to the shore, with the likely pipeline landfall locations on the Kenai Peninsula between Homer and Nikiski. With the exception of two subsea pipelines to the nearest landfall location and buried pipelines continuing over land to oil and gas facilities to Nikiski, no additional major onshore construction projects are expected as result of the Proposed Action. Two subsea pipelines would be placed in the same trench. The onshore length of each new buried pipeline is estimated to be 80 km (50 mi), with pipeline construction expected to take place between May and September during year 6 of the E&D Scenario. Construction of a pipeline landfall could disturb a small area of coastal habitat for a brief period (e.g., several weeks). Given mitigation requirements of the USACE regulatory program, the pipeline landfall construction would likely avoid high value wetland habitats located along a portion of the shoreline that have either no vegetated wetlands, or a minimal fringe of wetlands above the high tide line that would be mitigated. The analysis of impacts to coastal and estuarine habitat assumes mitigation, at most minor impacts would occur.

If a coastal vegetated wetland is impacted by the construction of the pipeline landfall, then typically mitigation would be required to re-establishment or rehabilitation of the wetland (restoration); once construction is completed, the subsea pipelines would likely be below the coast’s beach and/or wetland as the pipelines transitions from Cook Inlet to an upland area on the Kenai Peninsula. A three-step process is typically required by regulatory agencies called mitigation sequencing for wetland impacts (40 CFR 230(J), 33 CFR Part 332). Step 1 is to avoid adverse impacts to aquatic resources. Step 2 is to minimize impacts that cannot be avoided. Step 3 is to use appropriate and practicable compensatory mitigation for unavoidable adverse impacts. Site-specific concern would be considered to avoid high value coastal habitats, such as vegetated wetlands at the mouths of rivers and streams entering Cook Inlet. If a minimal amount of wetlands cannot be avoided and it is not practical to reestablish vegetation lost to excavate the trench for the pipeline, then possibly a need to armor the buried pipelines with a revetment, or such other compensatory mitigation would be considered. Site specific mitigation would be required to minimize temporary construction impacts.

Depending on the subsea pipeline route and landfall, then connection to the existing onshore pipelines right-of-ways could require clearing of vegetation in previously undisturbed landscapes. Expected onshore facilities inland from the pipeline landfall could include a pigging facility and pump station in an upland area. In upland area where there would not be maintain permanent facilities there is no regulatory requirement to replace vegetation; however, successional stages of natural plants would occur. Pioneering species of grasses and weeds would begin to replace upland vegetation within the first year following the construction of the onshore pipelines. Shrubs and other upland ground cover would naturally reestablish in 2 to 3 years. Where trees would be removed, they would naturally reestablish over a period of about 10 years.

The Kenai Peninsula has a vast amount of emergent wetlands; all possible pipeline routes between landfall and northward to the City of Kenai would cross wetlands. Approximately 11 hectares (~28 acres) of wetlands, including stream crossings, would be impacted to accommodate the construction of the two buried pipelines; this assumes the onshore pipelines would be constructed within the existing pipeline right-of-way that parallels the Sterling Highway northward from Homer, then along the Kalifornsky Beach Road before it crosses under the Kenai River and the Kenai River Flats's marsh, and finally along the Kenai Spur Highway to Nikiski.

The estimate of wetland impacts along the existing pipeline right-of-way assumes a 9 m (~30 ft) width of disturbance to accommodate the trench, construction equipment and temporary placement of the pipelines adjacent to the pipeline trench. The 9 m (30 ft) width would also accommodate excavation of material, temporarily stockpile, and the return of the excavated material as overburden to cover the pipeline. The area above the pipelines would be returned to preconstruction topography and wetlands would be reestablished, any excess backfill would be removed to an upland disposal site. In addition to the approximately 11 hectares (~28 acres) impacted, construction would also disturb approximately 61 hectares (~151 acres) of upland and based upon the same width of disturbance. The entire 72 hectares (~179 acres) of construction would be through wetlands and uplands that were previously disturbed by the construction of existing pipelines. The assumptions above are based upon a review of the Kenai Peninsula Borough Geographic Information System (http://www.kpb.us/gis-dept) Interactive Parcel Viewer map for wetlands and aerial photographs, the information available from the National Wetland Inventory Wetlands Mapper (http://www.fws.gov/wetlands/Data/Mapper.html), and with information from online maps of the existing pipeline alignments (http://www.arcgis.com/home/webmap/viewer.html?webmap=9204cc0e3e9c4af6ab330dce552de1bd). Impacts to wetlands from construction of the onshore pipelines would be minor and localized, since wetlands construction would be temporary disruption that would allow wetlands to reestablish and would be through previously disturbed wetlands and have less impacts than a route affecting more wetland areas that were not previously disturbed by pipeline construction.

The E&D Scenario assumes the onshore pipeline construction would occur during the period of May through September. However, to mitigate the wetland impacts along the estimated 80 km (50 mile) buried pipeline route, regulatory personnel at the Kenai Field Office of the USACE Alaska District (Jennifer Martin, May 3, 2016, Personal Communication) advised pipeline construction would likely have time of year restrictions. To minimize the impact in wetlands, construction would likely be limited to winter months when soils are frozen (December through February or during a shorter period). The vegetation and underlying organic soils would be excavated in blocks, temporarily placed on geotextile mats, separate from mineral soils, and then replaced over the pipeline in re-established to preconstruction alignment. The topography would be required to be restored, and the wetlands would remain functioning and intact within the year following construction. An alternative method to excavation of a trench, pipelines placement, and backfill would be the use of a vibratory plough capable of burying the pipeline. If vehicles used in wetlands are not on low pressure wide (rolligon type) tires, then excavators, vibratory ploughs, trucks and other vehicles would be required to operate on mats, to minimize crushing vegetation.

Minimal to negligible impacts to riparian wetlands and flowing waters at stream crossings would result from mitigated methods that would be expected and typically required by regulatory agencies. Horizontal directional drilling would be required to place the oil and gas pipelines under the Deep Creek, Ninilchik River, Kasilof River, and Kenai River crossings; as well as any other crossings of regulated Anadromous Fish Streams (Jennifer Martin, May 3, 2016, Personal Communication).

Construction impacts from the E&D Scenario would be temporary and minor impacts at the landfall of the subsea pipeline, and the onshore pipeline through the existing pipeline right-of-way through wetlands and under streams. However, beyond the NEPA requirements other state and Federal regulatory requirements are typically expected as mitigation and would result in time of year restrictions, such that construction in vegetated wetlands be accomplished during periods of frozen soil and require specific methods that would further minimized impacts to vegetation from compaction and re-establishing functioning wetlands; the impact to wetlands would be negligible. Construction impacts at Anadromous Fish Stream crossings would also be negligible with mitigation requiring horizontal directional drilling.

4.3.9.5. Accidental Oil Spills and Gas Release

Appendix A provides detailed technical information used by BOEM to develop the set of assumptions on which the analysis of oil spills and gas releases are based for the entire life of the E&D Scenario. Section 4.2.14 summarizes the estimated spill sizes and volumes for the duration of the Proposed Action. More detailed descriptions of estimated spills and their potential volumes over each phase of the projected activities are presented in Appendix A.

Small Oil Spills (<1,000 bbl)

The estimated numbers of small spills in the Proposed Action are summarized and discussed in Section 4.2.14. Small spills under the Proposed Action include spills of diesel fuel, and refined and crude oil. The magnitude and severity of impacts would depend on the spill’s location and size, the type of product spilled, and environmental conditions at the time of the spill.

Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface, disperse, and weather rapidly. Among refined petroleum products, diesel fuel is considered to be highly toxic (Irwin et al., 1997) because it is enriched in PAHs (Clark, 1989; Craddock, 1977; National Toxicology Program, 1986).

Although much of the refined oil spilled in a small incident is expected to evaporate or naturally disperse into the water column within a few days, the rate of weathering depends on temperature, light, and other environmental conditions. Once dispersed into the water column or settled into substrates, petroleum compounds such as PAHs and heavy metals can remain bioavailable in lower concentrations, and still pose a risk to coastal habitats and animals that come into contact with these compounds.

Small spills of crude oil will persist longer in the environment and result in greater impacts than spills of refined products. The majority of the estimated small accidental spills would be <50 bbl, would quickly dissipate, and could affect a small amount of habitat and relatively few individuals. Small spills ≥50 bbl but <500 bbl would similarly be relatively easy to contain and would affect small areas of habitat and few individuals.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large oil spill under the Proposed Action includes spills of refined and crude oil. The magnitude and severity of impacts would depend on the spill location and size, the type of product spilled, and environmental conditions at the time of the spill. Under the Proposed Action, BOEM estimated that the size of a large spill from an OCS pipeline is 1,700 bbl, while the estimated size of a large spill from an OCS platform is 5,100 bbl.

A large spill of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface, disperse, and weather rapidly. The volatile components of the fuel would evaporate within 24 hours, although a small proportion of the heavier fuel components could adhere to PM in the upper portion of the water column and sink. A large spill of crude oil will persist longer in the environment and result in greater impacts than spills of refined products.

Alaska’s waters are rich in biological resources that are sensitive to spilled oil. These waters are also host to oil exploration and production activities as well as heavy vessel traffic, and are bordered by land-based facilities that transfer, store, and handle oil. This combination of sensitive resources and potential oil spill sources increases the risk of a damaging spill (Sanjarani et al., 2015). Important areas for biodiversity and sensitive ecosystems are considered sensitive to oil spills because they are (1) of environmental, economic, or cultural importance; (2) at risk of coming in contact with spilled oil; and (3) likely to be affected once oiled, or affected by the oil even without direct contact (Sanjarani et al., 2015). The resulting biological effects that support resources of intrinsic and economic importance may be longer lasting and, in some cases, permanent (Boesch et al., 2005).

The vulnerability of different shore types to oil pollution largely depends on substrate and wave exposure; Table 4.3.2-20 presents shoreline vulnerability to oiling using the criteria of Gundlach and Hayes (1978).

Table 4.3.2-20. Vulnerability of Cook Inlet Shorelines to Oil Pollution

Shoreline Type	General Location in Cook Inlet	Vulnerability to Oil
Exposed rocky cliffs and headlands	Southern Cook Inlet	Low vulnerability. Wave reflection keeps most of the oil offshore.
Fine- and coarse-grained beaches	Middle and upper Cook Inlet	Low to moderate vulnerability. Where oil penetrates into the sediment, may persist over several months.
Mixed sand and gravel beaches; shingle beaches	Middle and upper Cook Inlet	Moderate to high vulnerability. Oil may penetrate rapidly and be buried resulting in persistence over years. Solid asphalt pavement may form under heavy oiling conditions.
Sheltered rocky coasts	Southern Cook Inlet	Moderate to high vulnerability. Oil may persist for years.
Sheltered tidal flats	Middle and upper Cook Inlet	High vulnerability. Low wave energy; high productivity and biomass. Oil may persist for years.
Salt marshes	Middle and upper Cook Inlet	High vulnerability. Highly productive. Oil may persist for years.

Modified from: Gundlach and Hayes (1978).

As described in Table 4.3.2-20, Cook Inlet coastal habitats are varied and have different vulnerabilities to oil exposure; persistence of oil also varies between habitats once exposed. Porosity of the shoreline substrate, is an important determinant of the extent to which the shoreline may be impacted by an oil spill. Shorelines in upper Cook Inlet are primarily sheltered tidal flats and salt marshes, which are highly sensitive to oil spill impacts; in contrast, shorelines in middle Cook Inlet are characterized by exposed tidal flats that are less sensitive to oiling (NOAA, 2002b). Shoreline types in lower Cook Inlet are more diverse.

As described in Section A-2.2 and Table A.1-2 of Appendix A, ESI shoreline types for LSs in Cook Inlet and Shelikof Strait are characterized by approximately 49% exposed rocky shorelines, 31% mixed sand and gravel beaches, 12% gravel beaches, 2% coarse-grained sand beaches, 3% exposed tidal flats, and <1% marshes. Stranded oil may mix deeply (up to a meter) into well-sorted sand and gravel substrates. During the Exxon Valdez Oil Spill, most exposed rocky shorelines showed little to no oil persistence besides staining and scattered tar blotches (Gundlach et al., 1990). On a small scale, however, these rocky shorelines can be indented and fractured, with numerous pockets that are sheltered from waves and wind, where oil can be trapped and natural weathering processes inhibited. On some exposed rocky shores in Prince William Sound, heavy oil concentrations were found 8 months after the Exxon Valdez Oil Spill (Gundlach et al., 1990). Twenty-five years of research on the Exxon Valdez Oil Spill has documented the surprising persistence of toxic components of oil in the environment (EVOSTC, 2015).

Mixed sand and gravel beaches were a shore type particularly affected by the Exxon Valdez Oil Spill (Gundlach et al., 1990), and gravel beaches pose a special problem because of the potential for deep oil burial and the persistence of subsurface oil for decades (Hayes and Michel, 1999; Hayes, Michel, and Fichaut, 1991; Irvine, Mann, and Short, 1999; Michel and Hayes, 1993b; Michel et al., 1991; Owens, 1991, 1993). Gravel beaches enhance oil accumulation through burial by accretionary features and the formation of asphalt pavement; the resultant armoring of the gravel beach impedes erosion (Hayes, Michel, and Fichaut, 1991; Michel and Hayes, 1993a,b). Oil persistence depends on wave energy, with sheltered areas harboring oil for years to decades (Prince, Owens, and Sergy, 2002).

The ESI predicts longer persistence on coarse- rather than fine-grained sand beaches. On fine-grained sand beaches in Katmai, oil remained on or near the surface (Gundlach et al., 1990). Clay-oil flocculation is identified as a process on fine-grained sand beaches that accelerates weathering and prevents asphalt-pavement formation, thereby reducing oil persistence (Bragg and Yang, 1995).

On exposed tidal flats, it is estimated that most oil would be pushed across the tidal flat onto adjacent shorelines. The high ESI classification (indicating high sensitivity) is due to the biological components using the tidal flat. Coarse cobbles on the tidal flat can also cause oil to persist for several months (Gundlach et al., 1990).

Marshes have the highest ESI ranking of eight. The ESI predicts long-term persistence for oil in marshes due to the sheltered nature of the shoreline and the fine-grained sediments. Examinations of past spills confirm the long-term persistence of oil in marshes (Reddy et al., 2002; Wang, Gross, and Taylor, 2001), and data from the Exxon Valdez Oil Spill also indicate long-term oil persistence in these environments (Gundlach et al., 1990).

Cook Inlet and Shelikof Strait shorelines are characterized by high wave exposure and energy, which may accelerate weathering processes or potentially hinder them due to boulders armoring the substrate (Irvine, Mann, and Short, 1999; Short et al., 2007). Some of the coastal environments adjacent to the proposed Lease Sale Area were oiled by the Exxon Valdez Oil Spill.

As described previously, oil spill persistence on water or on the shoreline can vary widely, depending on the size of the oil spill, the environmental conditions at the time of the spill, the substrate of the shoreline, and especially in the case of portions of Cook Inlet, ongoing shoreline erosion.

In addition to shoreline types, coastal and estuarine habitats are characterized by supratidal, intertidal, and subtidal communities, which serve as important conduits of energy, nutrients, and pollutants between terrestrial and marine environments; provide resources for subsistence, sport, and commercial harvests; and are important for recreational activities such as wildlife viewing and fishing. The supratidal zone is the area above the high tide line on coastlines and estuaries that is regularly splashed but not submerged by ocean water. Marine intertidal habitats consist of rocky shores and unconsolidated shores (e.g., beaches, sand bars, flats). Intertidal flats occur extensively in most coastal regions of Alaska. This habitat often lies seaward of salt marsh areas, at river mouths and deltas, along rocky coasts, or in lagoons. In

Cook Inlet, rocky substrates are juxtaposed with sand beaches and mud tidal flats, ranging from completely protected beaches to those with extreme wave exposure. Expansive tidal marshes and smaller marshes lie at the heads of protected bays and fjords. Tidal flats appear at low tide, largely as unvegetated expanses of mud or sand (Field and Walker, 2003). Intertidal flats are often intricately mixed with areas of estuarine emergent wetlands or rocky shores. Intertidal habitats and species are vulnerable to surface oil pollution, or to windblown oil in the case of onshore maritime habitats (e.g., dune systems).

Subtidal habitats encompass all of the seafloor below the mean lower low water tide line to approximately 800 m (2,625 ft), although deeper habitats are often referred to as the deep benthos. Communities in the near subtidal areas typically are characterized by dense stands of kelp or eelgrass and comprise various invertebrate species such as amphipods, polychaete worms, snails, clams, sea urchins, and crabs. Subtidal habitats provide shelter and food for an array of nearshore fishes, birds, and marine mammals.

It is estimated that up to 13% of the oil spilled during the Exxon Valdez Oil Spill was deposited in subtidal zones. The direct toxicity of the oil as well as subsequent cleanup activities caused changes in the abundance and species composition of plant and animal populations below lower tides. Initial injuries were evident for several oil-sensitive species. Infaunal amphipods, a prominent prey species in subtidal communities, were consistently less abundant at oiled sites than at unoiled sites. Reduced numbers of eelgrass shoots and flowers were also documented and may have resulted from increased turbidity associated with cleanup activities. Two species of sea stars and helmet crabs also were less abundant at oiled sites when compared to unoiled areas. However, stress-tolerant organisms, including polychaete worms, snails, and mussels, were more abundant at oiled sites. It has been suggested that these species may have benefited from organic enrichment of the area from the oil, or from reduced competition or predation because more sensitive species were depleted (EVOSTC, 2014b).

Adverse impacts from a large spill may substantially affect intertidal communities. More than 2,253 km (1,400 mi) of coastline were oiled by the spill in Prince William Sound, on the Kenai and Alaska Peninsulas, and in the Kodiak Archipelago. Heavy oiling affected approximately 354 km (220 mi) of this shoreline. It is estimated that 40% to 45% of the 11 million gallons of crude oil spilled by the *Exxon Valdez* washed ashore in the intertidal zone. For months after the Exxon Valdez Oil Spill in 1989, and again in 1990 and 1991, oiling and intensive cleanup activities had significant impacts on the flora and fauna of this environment. Initial impacts to the intertidal zone occurred at all tidal levels and in all types of habitats throughout the oiled Exxon Valdez Oil Spill area (EVOSTC, 2014b).

The type of oil is a primary determinant of toxicity on plants in nearshore communities. Heavy crude oils have a small amount of direct toxicity to plants, whereas light crudes can cause necrosis and plant mortality on contact (Mendelssohn et al., 2012). Even highly toxic refined products such as diesel, if they are weathered enough, will eventually lose toxicity, but the less toxic residuals can still coat vegetation (Mendelssohn et al., 2012). This condition prevents photosynthesis, thereby impairing the assimilation of carbon used for growth and transpiration, which promotes evaporative cooling. The frequency of repetitive oiling of vegetation also is an important determinant of the ultimate injury; repetitive oiling depletes the underground nutrient reserves used to generate new shoots after successive re-oilings (Mendelssohn et al., 2012). The time of year in which an oil spill occurs also influences the spill's impacts on plants. Spills during colder periods, when the plants have a lower metabolism or are dormant, have a reduced impact relative to oil exposure than during warmer seasons (Alexander and Webb, 1985, as cited in Mendelssohn et al., 2012). However, arguably the most important determinant of severity is whether the oil penetrates the soil and comes into contact with nutrient-absorbing roots and shoot-regenerating rhizomes; this scenario can cause plant death (Mendelssohn et al., 2012). Perennial marsh plants, which regenerate new aboveground shoots each spring, usually recover from stem and leaf oiling, but oiling of subsurface plant organs often results in plant death. Plants show varying susceptibility to oil, and species-specific differences in responses to oil can be dramatic (Lin and Mendelssohn, 1996, as cited in Mendelssohn et al., 2012).

As described previously, large oil spills can cause minor to major impacts to coastal and estuarine ecosystems, with potentially long-lasting effects. The actual impacts to coastal and estuarine habitats will depend on the location, season, extent, and type of fuel spilled.

Although unlikely, BOEM estimates that one well control incident involving a single well could release 8 MMcf of natural gas in one day. Most gas escaping and contacting water would dissipate quickly, likely resulting in no large-scale effects on coastal and estuarine habitats; however, some habitats in the near vicinity of a large natural gas release could be exposed to toxins before the gas could volatize. Large gas releases are expected to have negligible to minor effects on coastal and estuarine habitats.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%. There is a 1% chance of one or more large spills occurring and contacting Northern Kodiak (LS 83) within 30 days. There is <0.5% chance of occurrence and contact farther south or eastward. Combined probabilities of 1% or greater within 30 days include LSs 83, 62, 56, 36, 35, 34, 31, 30, 29, 28, 26, and 25.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread. Spill impacts and cleanup operations would be influenced by time of year in Cook Inlet; in particular spill response can be both hindered and aided by the presence of ice (see discussion in Sections 4.3.2.4.6 and 4.3.2.5.8).

Mechanical recovery of spilled material would generally improve oil spill impacted coastal and estuarine habitats. Mechanical means either preclude an oil spill from reaching coastal and estuarine habitats, or are used to remove oil and residue from coastal and estuarine habitats. If containment booms are deployment before the oil contacts the vegetated wetlands and/or the substrate and skimmers are used to recover the spill, then impacts to coastal and estuarine habitats would be minimized. If the length of a containment boom's skirt is too long and it drags on the bottom, sediments could be disturbed and more readily mixed with oil. For oil spill recovery to preclude onshore impacts with sediments, NOAA (2001) expressed caution for the use of correctly sized containment booms during nearshore deployment and/or recovery of containment booms in shallow habitats, while deflecting oil away from shore, or to trap and collect oil at the shoreline and prevent stranded oil from refloating and affecting adjacent areas, and when preventing oil being washed over a beach into a lagoon or backshore area. Physical damage from containment and collection procedures could occur if the effective current (tidal or stream flow) or towing speed exceeds 0.7 knots perpendicular to the boom; environmental effects would be minimal, if disturbance during deployment and maintenance is controlled (NOAA, 2010). Negligible to minor impacts would be increased in the event either booms or skimmers cause bottom sediments to be disturbed and mixed with the oil spill during mechanical recovery; these impacts would be localized and expected to be short-term in shallow coastal areas. Minor environmental effects from other mechanical recovery methods may also enhance oil penetration and quantity of contaminated sediments, including the placement of a physical barriers consisting of earthen berms, trenching, or filter fences. NOAA (2010) indicated such recovery methods may disrupt or contaminate adjacent vegetation as well as sediments. Coastal beaches or the shoreline profile should be restored depending upon the local conditions; recovery may take weeks to months on gravel beaches (NOAA, 2010) and years to decades in isolated locations along the coast in Prince William Sound (Gilfillan et al., 1995; Page et al., 1995; Short et al., 2004; Ballachey et al., 2015).

However, the toxicity from oil subsided following the 1989 Exxon Valdez Oil Spill as residues of weathered were highly asphaltic, not readily bioavailable, and not toxic to marine life by 1991, the environmental effects became negligible (Boehm et al., 1995; Page et al., 1995; Short et al., 2004). While PAH toxicity from oil reaching the intertidal wetlands would likely be a short-term impact, dissipating within one year, the asphalic residues would smother and result in a long-term loss of local habitat. High pressure washing in intertidal habitats was a destructive mechanical method used during the Exxon Valdez Oil Spill (Lees, Houghton and Driskell, 1996; Hoff and Shigenaka, 1999); while this form of washing would improve water quality, the loss of intertidal fauna and flora along with finer sediments was substantial and not expected to be used in the future.

Use of dispersants generally would be deployed to prevent injury to shoreline to dilute and disperse before an oil spill contacts coastal and estuarine habitat (Scholz et al. 1999). By reducing the oil/water interfacial tension, waves can more easily break up oil into larger number of smaller particles (NOAA, 2010). Relative to the spill, the dispersed oil including the dispersants would add little to no negative impacts if an oil slick is precluded from contacting the coastal and estuarine habitat. However, the dispersed oil could adversely organisms in the upper water column until the dispersed oil and dispersant is sufficiently diluted; and the use of dispersants in shallow water could affect benthic resources (NOAA, 2010); see the Spill Response Activities discussion on lower trophics in Section 4.3.4.6. The net effect of dispersants would reduce impacts to sensitive shoreline habitats and animals that use the water surface, and result in less PAH remaining on the surface, subsequently migrating into the water column and impacting coastal and estuarine habitats. When dispersed within the water column, natural biodegradation can occur, potentially reducing acute (immediate) and chronic (long-term) toxicity to organisms (Scholz et al. 1999). The dispersant is unlikely to contribute substantially to adverse effects, even in multiple applications (Boyd et al., 2001).

Under the ideal conditions in-situ burning would be the most effective to preclude coastal and estuarine habitat impacts. In-situ burning of spilled oil floating slicks, early in the spill event and prior to contacting the shore, is effective in removing oil from the surface of the waterbody when contained in fire-resistant booms or any natural barriers such as ice or the shore (NOAA 2010). In-situ burning is upwards of 90% effective in removing the spilled oil according to the Scholz et al. (2004). Oil can also be burned on land when it is on a combustible substrate such as vegetation, logs, and other debris (NOAA 2010). In the affected area of a burn plants and animals can be consumed by the flames; depending on conditions, root plants may be protected. Short-term loss of up to one growing season would be expected for revegetation of erect, rooted, herbaceous hydrophytes lost by the in-situ burning in estuarine marshes, as long as erosion is not enhanced by the loss of vegetation. If an oil slick is forced beyond the intertidal area to freshwater wetlands and in-situ burning results in the loss of freshwater scrub-shrub species and tree losses would result in long-term recovery of vegetation. After the in-situ burn the remaining residue is non-toxic, but could act as a physical barrier to revegetation (Scholz et al., 2004). Removal of the residue would be desired in most cases to benefit the reestablishment of aquatic and/or terrestrial life (Scholz et al., 2004). There could be localized minor negative impacts vegetated wetlands of coastal and estuarine wetlands.

4.3.9.6. Impact Conclusions

The expected direct impacts to vegetation and wetland resources as a result of routine activities in the E&D Scenario are **minor** because they would be localized. These impacts would not have a severe effect on the ecological functions, species abundance, or composition of wetlands and plant communities of Cook Inlet. However, mitigation typically expected by regulatory agencies, would result in **negligible** impacts from onshore pipeline construction by restricting wetland construction methods and to the time of year when soils are frozen. Also, mitigation typically expected by regulatory agencies would require pipeline crossing of Anadromous Fish Streams and their riparian wetlands to be minimized through use of horizontal directional drill. Impacts from small spills would be **minor** because they would be short-term and only impact a geographically limited area. It is expected that most small spills would evaporate before reaching coastal and estuarine habitats.

The direct and indirect impacts of a large spill to coastal and estuarine habitats, including large oil spills, could be **major**, depending on the location of the large spill. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for coastal and estuarine habitats for routine activities or accidental spills. Also, GUIE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for coastal and estuarine habitats with regard to routine activities.

4.3.10. Economy and Population

IPFs that could affect the economy and population are (1) employment and project spending; and (2) accidental oil spills and gas releases. Exploration, development, and production would generate direct employment and direct earnings. In turn, the direct employment and earnings would generate indirect employment and earnings and employment and earnings induced by the project (i.e., exploration, development, and production). Together, direct, indirect, and project-induced employment and earnings would influence potential growth in the local population and would determine the total fiscal effect to the Kenai Peninsula Borough (KPB), State of Alaska, and Federal Government. The analysis looked specifically at employment and income impacts to the KPB, the location of the Proposed Action. The estimates in this section are based on one potential development scenario. As stated in the E&D Scenario, the assumptions used to project impacts are based on only one possible view of how resources may be developed if they are found.

4.3.10.1. Employment and Project Spending

Employment and spending would vary with phases of the E&D Scenario. During the exploration phase, seismic surveys, including geohazard and geotechnical work, and exploration and delineation drilling would generate direct project-related employment. During the development phase, platform installation, development drilling, and pipeline construction would be the primary sources of direct employment. Finally, during the production phase, there would be platform and shore-based employment to produce oil and gas. The direct employment would generate indirect and project-induced employment and wages.

Some of the projections of work and employment are based on current and planned activities associated with offshore development in Furie Alaska's Kitchen Lights Unit and BlueCrest Energy's Cosmopolitan Unit. As these are the first offshore developments in Cook Inlet since 2000, they were used as analogues for what actual OCS development might look like. The Kitchen Lights Unit commenced production in November 2015. BlueCrest Energy's Cosmopolitan Unit is in the feasibility planning stage. All actual employment and earnings from the Proposed Action, if implemented, would depend on specific project characteristics and other factors such as the price of oil.

Direct Employment and Earnings[3]

Table 4.3.2-21 summarizes the projected direct employment that the E&D Scenario would generate by year. The categories include extraction (production), drilling (exploratory, delineation, and developmental

[3] Because this EIS focuses on impacts in the KPB, employment and earnings estimates do not include employment outside the borough. In addition, unlike BOEM's internal regional economic impact model MAG-PLAN Alaska (which generally is used for the much larger state-wide estimates), employment from expenditures on supporting functions performed outside the borough—such as manufacturing of equipment and chemicals, engineering and environmental consulting, transportation of goods to Alaska, and other expenditures not related to activities that occur in and adjacent to Cook Inlet. For these and other reasons, results in this EIS cannot be directly compared to MAG-PLAN results.

drilling), and support activities. Projected employment for decommissioning are not expected to be significant and are not shown. Support activities include seismic, geohazard, and geotechnical surveys and pipeline construction and operation and maintenance. Peak direct employment is projected to occur in project year 6 at 230 direct employees. After reductions in project years 7 and 8, there is a secondary peak of 192 direct employees projected in project year 9. Year 6 is when most of the pipeline construction would occur; 80 km (50 mi) of onshore pipeline, 97 km (60 mi) of offshore oil pipeline, and 97 km (60 mi) of offshore gas pipeline. The rest of the offshore pipelines would be constructed during years 7 and 9. Production is projected to ramp up substantially between project years 8 and10. Direct employment estimates show varying increases and decreases until project year 14 when direct employment stabilizes at 52 workers. These increases and decreases would occur because of the ever-changing status of the project in the pre-production phases.

Table 4.3.2-21. Direct Employment Adjusted for Non-Resident Labor[1]

Project Year	Extraction[2]	Drilling[3]	Support[4]	Total
1	0	0	42	42
2	0	41	53	94
3	0	41	22	63
4	0	27	0	27
5	0	27	0	27
6	0	0	230	230
7	12	11	68	92
8	25	34	15	74
9	25	46	121	192
10	37	57	15	109
11	37	57	15	109
12	37	23	15	75
13	37	23	15	75
14-33	37	0	15	52

Notes: [1] Entries adjusted for 18% non-resident workforce.
[2] Includes production.
[3] Includes exploration/delineation and development drilling.
[4] Includes seismic, geohazard, and geotechnical surveys as well as pipeline construction, operation, and maintenance.

Source: Owl Ridge Natural Resource Consultants, Inc. (2015).

The figures in Table 4.3.2-21 are adjusted for non-resident employment. Approximately 18% of the Kenai Peninsula Borough oil and gas industry workforce in 2011 was composed of non-Alaska residents who commute (McDowell Group, 2013).

In addition, the analysis assumed that installation of the platform would proceed similarly to the Kitchen Lights Unit platform, which commenced production in November 2015 in Cook Inlet and consists of modular components built elsewhere and shipped to Alaska. Specialized crews from the Gulf of Mexico constructed the platform because its construction required specialization. The crews reside on support vessels, rarely interacting with the community, and most vendor supplies are from outside Alaska.

Table 4.3.2-22 shows the estimated earnings, using local wage data, that direct employment would generate. The average annual wage for oil and gas industry employment in the KPB in 2011 was $98,445 (McDowell Group, 2013), or approximately $109,000 in 2015 dollars. The increases and decreases in estimated direct earnings follow the same patterns as direct employment, with a peak direct income of $25 million in project year 6 and a second peak of $21 million in project year 9.

Project-related oil and gas direct employment and earnings would be easily integrated into the local and regional economies, which already include substantial contributions from other oil and gas activity. The projected level of new direct employment and earnings would not have a significant impact on existing conditions, although new employment and income opportunities would be considered beneficial to the local and regional economies.

Table 4.3.2-22. Direct Earnings Estimates for Lease Sale 244 Proposed Action

Project Year	Extraction Million 2015 USD	Drilling Million 2015 USD	Support Million 2015 USD	Total Million 2015 USD
1	0	0	5	5
2	0	4	6	10
3	0	4	2	6
4	0	3	0	3
5	0	3	0	3
6	0	0	25	25
7	1	1	7	9
8	3	4	2	9
9	3	5	13	21
10	4	6	2	12
11	4	6	2	12
12	4	3	2	9
13	4	3	2	9
14-33	4	0	2	6

Source: Owl Ridge Natural Resource Consultants, Inc. (2015).

Indirect and Induced Employment and Earnings

Direct employment and earnings generate indirect and project-induced employment and earnings through the value of goods and services purchased by workers, and the retail and wholesale jobs created when the workers spend their money on other products in the economy. The indirect and induced employment and earnings are estimated through multipliers.

For this analysis, the BEA RIMS II multipliers were used. In this case, the region is the KPB, for which BEA has estimated multipliers. Regional input-output multipliers are based on a detailed set of industry accounts that measures the goods and services produced by each industry, and the use of these goods and services by final users (McDowell Group, 2013). Specifics about the multipliers are discussed in Owl Ridge Natural Resource Consultants, Inc. (2015).

Based on these multipliers, the amount of indirect and project-induced employment and earnings were estimated. Table 4.3.2-23 summarizes the direct, indirect, and total employment the Proposed Action is projected to produce. Similarly, Table 4.3.2-24 summarizes the direct, indirect, and induced earnings Alternative 1 is projected to generate. Total employment and earnings estimates follow the same patterns as direct employment and earnings, with peaks in project years 6 and 9. Total employment and earnings are estimated to stabilize in project year 14 through the end of the production phase (project year 33). Overall, the new contributions to total employment and earnings from the Proposed Action would be beneficial to the local and regional economies.

Table 4.3.2-23. Direct, Indirect, and Induced Employment Estimates.

Project Year	Direct	Indirect	Induced	Total
1	42	13	23	78
2	94	25	48	167
3	63	16	31	110
4	27	6	13	46
5	27	6	13	46
6	230	70	127	427
7	92	28	49	169
8	74	22	37	133
9	192	57	101	350

Project Year	Direct	Indirect	Induced	Total
10	109	31	54	194
11	109	31	54	194
12	75	24	38	137
13	75	24	38	137
14-33	52	19	28	99

Source: Owl Ridge Natural Resource Consultants, Inc. (2015).

Table 4.3.2-24. Direct, Indirect, and Induced Earnings Estimates

Project Year	Direct Million 2015 USD	Indirect Million 2015 USD	Induced Million 2015 USD	Total Million 2015 USD
1	5	1	1	7
2	10	2	2	14
3	7	1	2	10
4	3	0	1	4
5	3	0	1	4
6	25	4	6	35
7	10	2	2	14
8	8	2	2	12
9	21	4	5	30
10	12	3	3	18
11	12	3	3	18
12	8	2	2	12
13	8	2	2	12
14-33	6	2	1	9

Source: Owl Ridge Natural Resource Consultants, Inc. (2015).

Population Effects

The previous section presents estimates for increases in jobs from Cook Inlet OCS activity. As noted, the estimates were adjusted for non-Alaska residents (i.e., workers who would commute in and out of the KPB from out of state). The remainder would reside in the KPB, given that the jobs are there. Beneficial effects to population would depend on the extent to which current residents are placed in the new jobs. Current residents may take these jobs to the extent there is unemployment in the KPB and to the extent that they have the necessary skills for those jobs or can be trained for them.

Current unemployment in the KPB is 7.4% (ADLWD, 2015a). Total employment in 2014 was 20,782 (ADLWD, 2014), which implies 1,538 are unemployed. Total population of the KPB in 2010 per the census was 55,400 (ADLWD, 2015b).

Although 1,113 oil and gas jobs exist within the KPB, 1,773 residents work in oil and gas occupations on the North Slope, where wages are generally higher than Cook Inlet. If a KPB resident who works on the North Slope gets a new job in the KPB, a vacancy would be created on the North Slope that presumably could be filled by another KPB resident or by a resident living outside the KPB.

More than 7,000 Anchorage and Matanuska-Susitna residents are employed on the North Slope. It follows that the propensity for them to move to the KPB would be low. It is not anticipated that any appreciable commuting would occur between Anchorage/Matanuska-Susitna and the KPB.

To account qualitatively and directionally for new jobs that would be held by current residents, the analysis assumed that 10% of the jobs would be taken by unemployed residents. This would be a peak of 43 jobs during development and 10 jobs during the production phase.

Based on the previous considerations, the increased population from the Proposed Action is estimated as the product of the increased total employment, adjusted for current residents taking new jobs, and the average number of people per household. The average number of people per household in the KPB was 2.5 from 2009 to 2013 (U.S. Census Bureau, 2013). Table 4.3.2-25 summarizes the estimated increase in population. Projected population increases from the Proposed Action follow the same pattern as the other impact analysis categories described earlier, with a peak in project year 6 and a second peak in project year 9. The peak new population estimate is 962 people in project year 6, and 785 people in project year 9. Again, depending on project status and phase, population impact estimates show varying increases and decreases until project year 14, when the projected population increase stabilizes at 222 people. The peak increase of 962 new people in the KPB would constitute an increase of <2% from current conditions. It is likely that some of the new population will leave the area as their jobs end, although they may stay in the area and find alternative employment.

Table 4.3.2-25. Total Population Impact.

Project Year	Number of People Added
1	177
2	377
3	246
4	103
5	103
6	962
7	381
8	299
9	785
10	439
11	439
12	308
13	308
14-33	222

Source: Owl Ridge Natural Resource Consultants, Inc. (2015).

Fiscal Effects

Development would occur in Federal waters. Consequently, the state and KPB would not receive bonus bids, royalties, production, or state corporate income taxes unless production occurred in the 8g zone. The KPB would receive property taxes for infrastructure built onshore on borough land.

The KPB would receive taxes for assets such as onshore pipelines on KPB land. Based on an estimated 100 miles of onshore pipelines, over the 40-year life of the project the KPB would receive approximately $8 million and the State would receive $27 million in property taxes. The Federal government is estimated to receive $3.6 billion in royalties and $7.2 billion in income taxes over the life of the Proposed Action. All amounts are in 2015 dollars.

The Federal Government's revenues would include royalties on the oil and gas and corporate income taxes. Federal royalties from the lease sale would be based on the volumes of oil and natural gas extracted over the life of the project, which are projected to be 150 to 215 MMbbl of oil and 81 to 571 Bcf of natural gas. The royalty would be the gross value at the lease boundary, which is the market price less pipeline tariffs. The royalty rate was assumed to be 12.5%, the same as Cook Inlet Sale 191. Total Federal royalties from project years 7 through end of production phase of the project (year 33) are projected to be $3.6 billion in 2015 dollars. This estimate is based on the upper end of the projected extraction ranges for oil and gas. Should extraction levels fall short of the maximum projected estimate, there would be a corresponding proportional reduction in royalties.

Federal corporate income taxes are gross revenues minus expenses, subject to the tax rate, which is 35%. Gross revenues for oil and gas are estimated at a total of $28.8 billion based on the upper end of the projected extraction ranges for oil and gas. Should extraction levels fall short of the maximum projected estimate, there would be a corresponding proportional reduction in revenues. Because of potential variations in how development would occur and the uniqueness of the operating environment, considerable variability surrounds these cost estimates. Owl Ridge Natural Resource Consultants, Inc. (2015) provided additional discussion on the factors that were considered in estimating the costs. Finally, total estimated income taxes are estimated at $7.2 billion, starting in project year 7 through the end of the production phase of the project (year 33).

4.3.10.2. Accidental Oil Spills and Gas Release

Non-routine events of primary concern to the economy and population are accidental spills of oil or releases of natural gas into the environment. Effects of a spill on the economy and population would depend on spill size, location, and trajectory.

Small Oil Spills (<1,000 bbl)

As discussed in Section 4.2.14, small spills could involve diesel fuel, crude oil, or condensate. Small spills could originate from various sources, including vessels, platforms, and pipelines. Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface, disperse, and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and are not expected to affect the economy or population. Small spills of crude oil could persist longer in the environment but would result in little to no impacts to the economy and population. Small crude oil spills can be mitigated using routine spill prevention measures. Small spills are expected to have an overall negligible effect on the economy and population of the KPB.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large oil spill could affect the local or regional economy in several ways, including direct and indirect effects to employment, income, and population. The most direct effects would be felt in industries that depend on resources that are damaged or rendered unusable for a period because of the spill. For example, recreation, recreational fishing, commercial fishing, and subsistence harvest patterns would be vulnerable if a large spill damaged shorelines or fish resources. A large oil spill also could have noticeable short-term and localized economic impacts if it were to disrupt important transportation routes or affect the operations of local port facilities such as Anchorage or Homer.

Other economic effects of an oil spill are primarily determined by indirect actions or events that could occur along with the spill. For example, a large oil spill could lead to a temporary decrease in levels of oil and gas industry operations. These effects would be most strongly felt in the KPB because this is where OCS-related employment would be concentrated. The direct effects of an oil spill on a particular industry would ripple through the supply chain; consumer spending by employees of these firms also would have impacts to the broader economy. Decreased levels of offshore oil and gas activities could affect the revenue streams of the various levels of government in the impacted area.

Revenue impacts to local governments or the State of Alaska would be in the form of property tax revenues from any new onshore infrastructure built to house workers and other support infrastructure. However, if existing economic activity due to the spill is curtailed, government revenues could be lost.

The ultimate effects of a large oil spill on the economy and population would depend on several variables, including location of the spill, time of year, size of the spill, and weather conditions. If a large spill reaches shore, the economic effects could include impacts to real estate and man-made assets in addition to offshore effects.

Depending on the location and severity of a spill, it is possible that the spill could result in a Natural Resource Damage Assessment (NRDA). NOAA conducts NRDAs through a process that includes determination of the damages from a spill, quantification of those damages, and then restoration planning. The result of the NRDA process could have beneficial revenue impacts as the population of interest is compensated for a range of natural resources and environmental service values damaged by the oil spill.

Although unlikely, BOEM estimates that one well control incident involving a single well could release 8 MMcf of natural gas in one day. Released gas would disperse rapidly at the blowout site. A single day release of gas would not be expected to cause impacts to the economy and population.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island for up to 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Spill Response Activities

The response and cleanup operations following an oil spill often have long lasting and widespread effects to local or regional economies. For context, the Exxon Valdez oil spill consisted of a 260,000 bbl spill 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 from 1990 to 1992.

While the influx of workers to local areas can have a number of positive economic impacts, it can also disrupt the normal functioning of local or regional economies. In addition, the people and equipment that are dedicated to oil spill response efforts may be diverted from some existing services (e.g., hospitals, firefighting, and other emergency services) available to local residents.

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations.

Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, spill response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread. Spill response and cleanup activities are expected to have minor to moderate and beneficial effects on the economy but could have adverse effects (minor to moderate) to the population due to numerous stresses associated with remediation of environmental disasters.

4.3.10.3. Impact Conclusions

Overall, the effects of routine activities from the Proposed Action on the economy and population would be short-term and localized, and thus **minor** and beneficial. Exploration, development, and production activities would generate additional employment, earnings, and revenues for local, state, and Federal governments. However, the increase in employment, earnings, revenues, and population would be proportionally small compared to the current economy and population.

Adverse effects of a potential spill would be limited in scope and insufficient to offset the overall beneficial effects of the Proposed Action. The effects of small spills therefore would be **negligible**.

Although a large oil spill could have some identifiable effects on the economy, it is unlikely to measurably affect the local population. A large oil spill could disrupt the local or regional economy in several ways such as changes to employment, earnings, and revenues. Effects could accrue most directly to industries that depend directly on natural resources. The effects of a large oil spill could be somewhat broader if firms further along industry supply chains are affected. The ultimate level of effects depends on issues such as the scope and location of the spill, and responses of policymakers to a spill. Once the cleanup is completed, the economy would likely rebound to pre-spill conditions. Consequently, the overall effects of a large spill on the economy and population are expected to be short-term and localized, and thus **minor**. Effects from oil spill response and cleanup practices described in Section 4.2.14.3 are not expected to alter impact conclusions for economy and population for routine activities or accidental spills. Also, GUIE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for population and economy with regard to routine activities.

4.3.11. Commercial Fishing

IPFs that could affect commercial fishing include (1) seafloor disturbance and habitat alteration; (2) noise; (3) physical presence, including lights; (4) trash and debris (including non-hazardous domestic waste); (5) vessel traffic; and (6) accidental oil spills and gas releases. For purposes of analysis, the effects on the commercial fishing industry in Cook Inlet have been estimated on the basis of space-use conflicts due to routine activities, and separately for accidental spills.

Routine operations could affect commercial fisheries by causing short-term (or long-term) and primarily localized changes in the distribution or abundance of fishery resources, by reducing the catchability of fish or shellfish, by precluding fishers from accessing viable fishing areas, or by causing temporary losses or damage to equipment or vessels.

Temporary displacement of fishery resources from localized areas could occur as a consequence of seafloor disturbances and underwater noise associated with exploration, development, production, and decommissioning activities. The physical presence of the platforms, pipelines, and support vessels also could displace commercial fishing activities in the immediate area of offshore infrastructure. Following platform construction, there could be some highly localized changes in fish densities and species diversity in the vicinity of platforms due to attraction of some invertebrate and fish species, which could persist as long as the platform is present.

4.3.11.1. Seafloor Disturbance and Habitat Alteration

The effects to the seafloor habitat from exploration, development, and decommissioning activities are expected to be essentially the same for each of these phases. While there may be differences in the amount or type of activities associated with these phases, those differences would not make a measurable difference on the commercial fishing industry.

Seismic exploration vessels towing long cables could impact commercial fisheries in Cook Inlet. Commercial fishers could be impacted by the presence of drilling infrastructure and its operation. In January 1975, the 8,000-ton jack-up drilling rig *George F. Ferris* was moved into Kachemak Bay from upper Cook Inlet where it had experienced mechanical problems (Regalbuto et al., 1977). The rig was towed past the Bluff Point Dungeness crab grounds on the north side of the bay, where it allegedly entangled several dozen Dungeness crab pots. A few fishers were able to settle their claims for lost pots with industry. The *George F. Ferris* proceeded to drop its legs in Mud Bay, inside Kachemak Bay. The legs of the jack-up rig stuck firmly in 25 m (82 ft) of mud and clay. Later, when crews unsuccessfully tried to raise the legs by using the rising tide against the bottom of the rig, the *George F. Ferris* was swamped, creating an oil slick 3.2 to 4.8 km (2 to 3 mi) in length. A drilling platform's movements can entangle commercial fishing gear (e.g., longlines) or impact the seafloor. However, since the *George F. Ferris* incident, cooperation between the exploration industry and the commercial fishing industry has minimized these space-use conflicts. For the Proposed Action, industry could mitigate these types of impacts by talking with the commercial fishing community early and often about how to avoid similar disruptions to their fishing activities, and enter into agreements as they deem appropriate.

Similar to drilling activities, offshore construction on the seafloor, including placement of platforms and pipelines, may infringe to some extent on commercial fishing for groundfish and shellfish. Commercial fishers may be compensated for gear loss or damage attributable to offshore oil and gas operations;

however, BOEM cannot ensure that commercial fishers would be reimbursed for their losses to industry operations. Cook Inlet is currently closed to commercial crab fishing. In the event that commercial crab fishing in Cook Inlet reopened or was conducted for stock assessment purposes, conflicts with industry activities may be avoided by conducting seismic surveys during closed fishing periods or seasons. The navigation rules for vessel traffic would also serve to avoid potential conflicts.

Offshore construction, platforms, and pipelines are not likely to interfere with trawling. Offshore platforms would foreclose <1 km^2 (0.39 mi^2) each to longline fishing and trawling, assumed to pose a localized, and thus minor impact to the fishing industry. While a bottom trawler would not be able to pass over any exposed pipelines, the presence of an offshore pipeline would not interfere with longlining. Offshore construction activities carefully planned and coordinated with the commercial fishing industry may be able to minimize space-use conflicts, and therefore would have minor impacts on the commercial fishing industry.

The bays and beaches of Cook Inlet have several setnet sites where gillnets are anchored to the beach or slightly offshore; these are used to harvest salmon and herring. These operations are not likely to be impacted by seafloor disturbances in the proposed Lease Sale Area due to their typical distance from OCS activities.

No adverse impacts to fish hatcheries or aquatic farms from routine exploration and development activities are expected as a result of the Proposed Action.

4.3.11.2. Noise

The effects of noise on commercial fishing from activities related to exploration, development, and production are expected to be essentially the same for each of these phases. While there may be differences in the amount or type of activities, those differences would not make a measurable difference on the commercial fishing industry.

Changes in underwater sound can cause fish to alter their behavioral ecology, and can disturb and displace fishes, interrupt feeding, or impair their fitness. More extreme levels of underwater sound may cause injury or kill fish in a localized area (see Section 4.3.5). Changes in underwater noise from exploration, development, production, and decommissioning activities may temporarily alter the behavioral ecology of some fish, which could influence the commercial fishing industry in a particular area.

Active Acoustic Sound Sources

Active acoustic sound that would be produced as a result of the Proposed Action is discussed in detail in Section 4.2.5.1. Airguns are the typical acoustic sound source for 2D and 3D deep-penetration seismic surveys, impacting the seafloor habitat and species associated with it. Firing airguns during exploration activities would produce sound in surface waters, the water column, and seafloor habitats used by fish. The effects would vary in time and space depending on the type of activity, the number of ongoing activities, the peak pressure of the sources, the rate of rise and decay of the sound sources, and the juxtaposition of the actions.

These sound-altered survey techniques could temporarily 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 (Purser and Radford, 2011; Radford et al., 2010; Slabbekoorn et al., 2010). Even in cases where dispersal does not occur, seismic surveys could affect the behavior of some targeted species temporarily, thereby affecting catch rates in the immediate area of the survey (Davis et al., 2001). While some studies indicate that effects of seismic surveys on catch rates are likely to be limited to the time of the survey or for short periods (hours) thereafter (e.g., Skalski et al., 1992), catch rates for some species could be affected for longer periods (e.g., Engås et al., 1996).

Wardle et al. (2001) observed and tracked marine fishes (e.g. adult mackerel, adult pollock, and juvenile cod) on an inshore reef before, during, and after an airgun array was deployed and repeatedly fired on site. They found that airgun emissions caused startle responses in all observed fishes to an observable range of 109 m (358 ft) from the sound source and an SPL of 195 dB re 1 µPa. One of two fish tracked at the reef during the study was found to react as airguns fired at a range of 10 m (33 ft), whereby the fish immediately moved away from the airgun to a range of 30 m (98 ft).

Seismic surveys might directly cause temporary disturbance and dispersal of pelagic fish, and thus may reduce purse-seine harvests in a local area. This impact would be limited to the time of the survey, probably to no more than 1 hour following passage of the airgun array (Pearson, Skalski, and Malme, 1992). Purse-seine vessels typically fish from late spring through the summer annually, with some regulatory closed periods. These vessels harvest herring and salmon and work mainly within state waters.

Similar to purse-seine harvests, seismic surveys could affect the drift-gillnet industry because seismic noise may disperse herring and salmon, reducing catch. However, this is likely to be limited to the immediate area of the surveys and to the few hours of survey operations. Because the drift-gillnet industry normally fishes within 4.8 km (3 mi) of the beach, no direct impacts from seismic surveys are expected.

Information suggests that displacement of fish from use of airguns may be relative to the behavioral ecology of species involved (e.g., demersal versus pelagic). For example, inshore and groundfish species that are closely associated with live bottoms are not easily displaced from their home area (Wardle et al., 2001). Overall, seismic surveys are short-term and localized operations; hence, any fishes proximately displaced due to potential avoidance are likely to backfill the surveyed area in a matter of minutes to hours. Therefore, the impacts to commercial fishing would be minor.

Drilling and Equipment Noise

Exploration and production structures such as drillships produce a wide range of sounds at frequencies and intensities that may be detected by fish and shellfish. The noises generated from exploratory drilling differ from seismic surveys in two key ways: (1) they are less intense, and (2) they are more stationary and persistent.

Much of the noise associated with drilling and equipment use would increase sound 20 to 40 dB above background levels. BOEM anticipates that noise transmitted from fixed platforms would be weak due to the elevation of the structure and the lack of contact with the water column (USDOI, BOEM, 2012b). The nature of drilling and equipment noise would be vibrational, tonal, and at low frequencies.

In the short-term, direct effects from drilling sounds may frighten, annoy, or distract commercially harvested fish or shellfish, and lead to physiological and behavioral disturbances. These noises could cause species to leave a project site or adjacent area. Energetic consequences would depend on whether suitable food is readily available. However, over the long term, this impact could be naturally mitigated if a species becomes habituated to the noise produced by drilling activity, thereby potentially reducing the zone of displacement over time. Due to the relatively small size of a platform, height above the water, and existing underwater noise in Cook Inlet, noises emitted from a platform are unlikely to impact fish or shellfish in the surrounding waters.

Noise created from a drilling platform is not likely to measurably displace commercial fishing, because it forecloses <0.5 km^2 (0.19 mi^2) to commercial fishing. To avoid the drilling platform, a bottom trawler would need to divert course within 1.6 km (1 mi) of the structure under normal sea conditions. Furthermore, offshore platforms would foreclose <1 km^2 (0.39 mi^2) to longline fishing. Therefore, it is anticipated that any direct effects to commercial fisheries from the noise from drilling or equipment operations would attenuate within the imposed stand-off distances and would be considered short-term and localized, and thus minor. No direct or indirect effects to the hard shell clam or razor clam fishery would be expected from drilling or equipment noise.

Vessel Noise

Fishes inhabiting or transiting the proposed Lease Sale Area could be subjected to noise from offshore vessel traffic throughout the exploration, development, and production phases. Vessel activities may disturb pelagic and demersal fish and shellfish, potentially displacing them from preferred habitat, as vibrations and noise increase from vessels passing. Depending on the size of the vessel, pressure waves from vessel hulls could displace fish in the surface water habitat, and cause injury to or kill non-swimming and weakly swimming fish life stages and fish prey. Cavitation of bubbles generated by large vessel hull structures and vibrations from vessel pumps could result in barotraumatic injury and mortality of epipelagic non-swimming and weakly swimming fish life stages and fish prey (Hawkins and Popper, 2012).

As a result of the temporary change in background noise created by passing vessels, pelagic fish (e.g., herring, salmonids) in the immediate vicinity of vessels may exercise temporary and localized avoidance. It is likely that fish would return to an area once a vessel has passed, or would migrate and move from the area. Therefore, the temporary noise impact would have a minor impact on fish and the commercial fishery targeting pelagic species. Due to a vessel's position on the water surface, typical distance between the noise source and seafloor, and existing underwater noise in Cook Inlet, temporary passing noises emitted from a vessel are unlikely to impact commercially important shellfish in the surrounding seafloor, and are thus unlikely to affect commercial shellfishing activities.

4.3.11.3. Physical Presence, Including Lights

Physical presence of platforms and pipelines in the fishing grounds could create space-use conflicts for commercial fishers. Drilling platform movements can entangle nets, buoy lines, and longlines with consequent loss (see Section 4.3.11.1). However, formal agreements, communication, and careful cooperation between the seismic survey industry and the commercial fishing industry can minimize space-use conflicts.

Commercial fishers using the area near a production platform would lose access to fishing grounds to maintain a "safety zone" around the platform. Offshore construction of platforms could infringe on commercial fishing activities by excluding commercial fishing from adjacent areas due to such safety considerations. It is assumed that a safety zone of 500 m (1,640 ft) would be maintained by vessels around each production platform.

Fishers who would typically traverse these waters in route to or from their preferred fishing grounds would need to divert around the platform areas. This would represent a localized but long-term adverse impact to commercial fishers. Potential effects of platform construction and operations are expected to be highly localized but would most likely endure as long as the presence of the platform. Because a very small area of Cook Inlet would be affected, interference with commercial fisheries is expected to be minor.

The construction of pipelines would occur between the beginning of May and the end of September. Commercial fishing would be directly impacted during times of pipeline construction. Commercial fishers likely would be temporarily excluded from the local area during construction. Once constructed, pipelines can result in entanglement hazards for some types of fishing gear employed near the seafloor. The presence of an offshore pipeline typically would not interfere with the use of longlines, purse seines, driftnets (USDOI, MMS, 2003), or beach seines. However, during a bottom trawl, such as those employed by the commercial groundfish industry in Cook Inlet, trawl nets or lines could become snagged on exposed pipelines. Such potential effects of exposed pipelines are expected to be highly localized. New pipeline locations would be identified on navigational charts, and because a small area of Cook Inlet would be affected, interference with commercial fisheries would be expected to be minor.

Lights would be used on platforms during evening and night hours. Lighting on board the platforms can be designed to minimize nighttime impacts and could be used to ensure safety and security as well as when operations require lighting. Bright lights are known to attract numerous marine fauna, including small schooling fish and squid. These in turn attract larger predators, rendering each vulnerable to other predators. Fishes may be attracted by any platform's nighttime light-field or concentrations of prey that may be found in the waters around platforms (Shaw et al., 2002). The increase in prey availability around platforms could alter and attract pelagic fish, which may decrease the availability to commercial fishers fishing at night using a drift gillnet, for example. Together with the consideration for space-use conflicts discussed earlier, lighting could have a long-term (i.e., during the life of the platform) but localized (i.e. immediate vicinity of the platform) impact on drift gillnet fishing.

The primary effect to commercial fisheries would be from displacement of fishing boats and available fishing areas during exploration, development, production, and decommissioning. As such, physical presence of MODUs, platforms, and pipelines could have localized but long-term direct and indirect effects on commercial fishing, and thus a minor level of effect in spatial terms and a moderate level of effect in terms of duration, during all phases of the Proposed Action.

Industry can enter into agreements with commercial fishing associations and other commercial fishing groups to discuss how to reduce and mitigate effects from siting of platforms and other equipment and structures used as part of the Proposed Action. Formal agreements designed to reduce effects require effective communication practices and relationship building to be successful (SRB&A, 2013). Other mitigation measures include siting platforms outside fishing grounds, deferring riptide zones and other important areas from lease sales, establishing a fund that would reimburse fisherman for gear lost due to platforms, and establishing a vessel response program to assist in fishing emergencies related to platforms (Impact Assessment, Inc., 2004).

4.3.11.4. Trash and Debris (Including Non-Hazardous Domestic Waste)

During exploration, development, production, and decommissioning, trash and debris from vessels and platforms, whether accidentally or intentionally introduced into the marine environment, includes domestic waste, garbage, and plastics. Offshore operations generate trash made of paper, plastic, wood, glass, metal, and other materials. Debris, whether floating on the surface, suspended in the water column, covering the benthos, or deposited along the shoreline, can have deleterious impacts on pelagic and demersal fish and shellfish (Hoagland and Kite-Powell, 1997; Johnson et al., 2008).

Direct impacts to pelagic and demersal fish exposed to trash and debris range from superficial exposure to ingestion and related effects (EPA, 2015c). Fish and mobile shellfish can become entangled in trash and debris or ingest plastics that they mistake for food. The potential impacts to commercial fisheries would be short-term, localized, and likely affect a small number of individual fish or shellfish (see Section 4.3.5). As the impacts would likely affect a small number of individuals in the short term, the overall adverse impact of trash and debris discharge to commercial fishing would be considered minor.

4.3.11.5. Vessel Traffic

Exploration, development, production, and decommissioning activities utilizing vessels could have space-use conflicts with commercial fishing activities. Seismic surveys or drilling platform movements can entangle buoy lines and longlines with consequent loss. However, improved cooperation between the seismic survey industry and the commercial fishing industry has minimized these space-use conflicts and could be used to mitigate impacts for this project. Seismic and geotechnical surveys would likely require temporary restricted access to specific areas in Cook Inlet for fishers. For safety reasons, survey operators attempt to maintain a stand-off distance around the source vessel and its towed-streamer arrays, clear of other vessel traffic, and this can result in a space-use conflict with other vessels. The size of the stand-off distance varies depending on the array configuration; a typical stand-off distance would be approximately 8.5 km (4.6 nmi) long and 1.2 km (0.6 nmi) wide, covering 1,021 ha (2,523 ac) of the sea surface. With the source vessel moving at speeds of approximately 4.5 knots, the length of time that any particular point would be within the stand-off distance would be approximately 1 hour. Survey operators would submit information to the local USCG office and the local Harbormaster for issuance of a Local Notice to Mariners, which would specify the survey dates and locations and the recommended avoidance requirements.

The regional salmon fisheries commence in early May and continue well into September each year. In cases where drift-gillnet fishers fish farther out in Cook Inlet, space-use conflicts with seismic survey vessels, exploration drilling unit, and/or production platform are possible (see Section 4.3.11.3). Space-use conflicts associated with the transportation of platforms, or logistics associated with transportation of supplies or personnel between construction or production sites and shore bases, would need to be coordinated between the lessees and operators and the commercial fishing industry during planning exercises.

Compensation programs for loss or damage of commercial fishing gear attributable to offshore oil and gas operations could be developed. Most space-use conflicts are avoided by following existing marine navigational rules. To further address space-use conflicts, a stipulation for protection of fisheries has been proposed requiring lessees to review planned exploration, development, and production activities with potentially affected fishing organizations and port authorities to prevent unreasonable conflicts with commercial fishing gear. Under this proposed stipulation, there exists the possibility of applying further protections if deemed necessary to prevent unreasonable conflicts with commercial fishing operations. Other mitigation measures in response to increased vessel traffic include establishing seasonal restrictions on drilling, awarding drift gillnet captains concessions to regulatory restrictions on time and area, and establishing an organized and formal system of communication between drift gillnet boats and other vessels using Cook Inlet such as tankers (Impact Assessment, Inc., 2004).

It is anticipated that the increase in vessel activity that could occur as a result of the Proposed Action would result in spatially localized but long-term, and thus minor to moderate impacts to commercial fishing.

4.3.11.6. Accidental Oil Spills and Gas Release

Accidental discharge of oil can occur during almost any stage of exploration, development, production or decommissioning on the OCS, or in nearshore coastal areas. As detailed in Section 4.2.14, the two general spill size categories considered in the oil spill analysis are small spills (<1,000 bbl) and a large spill (≥1,000 bbl) and gas releases.

Small Oil Spills (<1,000 bbl)

As detailed in Section 4.2.14, BOEM estimates that small fuel spills during G&G activities throughout the life of the E&D Scenario would range from 0 to 13 bbl of diesel resulting from vessel-to-vessel transfers. During exploration and delineation drilling activities, BOEM estimates a typical discharge of 5 bbl of diesel fuel, and projects that at most one 50-bbl spill would occur over the life of Lease Sale 244 for a total estimated volume in four estimated spills of 65 bbl.

Small spills of refined oil would float on the water surface, disperse, and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and would not be expected to have population-level effects on commercially important fish or shellfish species. Small spills of crude oil would persist longer in the environment and could result in short-term and localized, and thus minor impacts to commercial fishing opportunities. These spills would occur predominantly within the confines of the production facility and its stand-off safety zone and would be short-term in duration. Small spills could be contained using on-site spill response resources; as a way to minimize the geographic extent of potential impacts to commercial fishing opportunities.

Relatively small spills are not expected to result in fisheries closures or reduced market values of fishes over the life of the Proposed Action. Hence, they are not expected to have an economic effect on the Cook Inlet commercial fishing industry.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A single large spill could depress numbers of fish in subpopulations of some commercially important fish or shellfish species inhabiting the proposed Lease Sale Area, although the level of effects would depend on a variety of factors. In the event that a large oil spill occurred, nearshore beach and intertidal fish habitats could be affected more adversely than other fish habitats because oil could persist in these areas for long periods of times, and prey organisms could be impacted for multiple generations. Even if fish stocks were not reduced as a consequence of a spill, specific fisheries could be closed due to actual or perceived contamination of fish or shellfish tissues. Such closures could result in long lasting and widespread impacts to commercial fishing and moderate losses of income for commercial fishers.

The economic cost of a large oil spill to the commercial fishing industry is primarily due to fishing closures, real or perceived catch tainting, and gear contamination. The oil spill that provides the most appropriate comparison to BOEM's estimated 5,100-bbl spill is the *Glacier Bay* oil spill, a 3,100-bbl tanker spill that occurred in upper Cook Inlet on July 2, 1987, during the commercial fishing season. The *Glacier Bay* oil spill primarily impacted the king and sockeye salmon fisheries in Cook Inlet. Losses reported by driftnet fishers ranged from approximately $10 to $108 million: setnet fishers reported losses ranging from $12 to $82 million (USDOI, MMS, 1990). The Exxon Valdez Oil Spill was approximately 60 times greater than the size of the *Glacier Bay* oil spill and resulted in maximum loss estimates of $40 to $45 million per year for commercial fisheries for the 2 years following the spill (Cohen, 1993).

The 5,100-bbl oil spill assumed for the Proposed Action is approximately 47 times smaller than the Exxon Valdez Oil Spill (260,000 bbl). However, since all 5,100 bbl would hypothetically be spilled into Cook Inlet, it is likely that an accidental Cook Inlet oil spill would deposit more oil (particularly fresh oil) in Cook Inlet than was introduced into Cook Inlet via the Exxon Valdez Oil Spill. Therefore, it is assumed that the 5,100-bbl oil spill would have at least an equal economic effect on Cook Inlet commercial fisheries as the Exxon Valdez Oil Spill had in this area, if it were to occur at the beginning of spring, the primary Cook Inlet commercial fishing season. If Cook Inlet and Prince William Sound commercial fisheries are assumed to have similar value, a large accidental oil spill is estimated to result in economic losses to the Cook Inlet commercial fishing industry of approximately $18 million (the sum of the lower 2-year Exxon Valdez Oil Spill loss estimates) to approximately $86 million (the sum of the higher 2-year Exxon Valdez Oil Spill loss estimates) (Cohen, 1993). Thus, the occurrence of a 5,100-bbl oil spill would be estimated to result in an economic loss to the commercial fishing industry of approximately $9 to $43 million per year for 2 years.

The occurrence of a 5,100-bbl oil spill during winter is likely to reduce the extent of closures and economic losses that would occur during the following spring and summer. Winter closures in areas where an oil spill occurred, or where oil contact was made, are possible; however, commercial fisheries focus on deepwater fishes in the winter, and likely would be much less affected by closures due to oil spills, primarily as a result of two factors:

- Winter weather in Alaska would quickly weather the oil (particularly the more toxic hydrocarbons) due to frequent winter storm activity.
- Most adult fish and shellfish would not be contacted by hydrocarbons from the spill because most hydrocarbons remain close to the surface.

For these reasons, and the fact that there are fewer ongoing commercial fisheries in winter, closure of commercial fisheries due to a large oil spill in the winter is much less likely than for a large spill that occurred in the spring. Therefore, economic losses to the commercial fishing industry due to a large winter oil spill likely would be less than expected for an identical spill occurring in the spring.

BOEM estimates that one well control incident involving a single well could occur under the Proposed Action, and release 8 MMcf of natural gas in one day. A large gas release and ensuing explosion and fire would kill any fish or shellfish in the immediate vicinity if it were subsurface. Blowouts of natural gas condensates that did not burn would disperse rapidly at the blowout site and would be unlikely to affect populations of commercially important fish or shellfish populations.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Because marine fish and shellfish resources are ubiquitous throughout open water habitats, specific concentration areas were not defined as ERAs. However, OSRA results for anadromous fish, whales, and seals (Sections 4.3.2.5 and 4.3.2.6) can be used to represent contact to commercial fishing.

OSRA results for anadromous fish resources (Table 4.3.2-7) indicate oil from large spills could contact LSs on the western side of Cook Inlet (LSs 18 to 36) and Kalgin Island (LS 38). LSs along the western shore of the Kenai Peninsula (LSs 54 to 58 and 60 to 63) could be affected during the summer. LSs along the western shore of the Kenai Peninsula and the southwestern shore of Cook Inlet contain numerous rivers and streams with anadromous runs of salmonids that could be affected during the summer and fall. The highest combined probabilities within 30 days range from 1% to 3% for the west side of Cook Inlet (LSs 30 to 36) and 0% to 1% for the east side of Cook Inlet (LSs 61 and 62). Oil contact with the shore and nearshore environment could alter the migratory behavior of returning adult salmon and impact forage fish such as herring and sand lance for one or more fishing seasons. Oil impacts could restrict commercial fishing activities in the proposed Lease Sale Area and potentially force fishing activities to relocate to avoid the large oil spill. As shown in Appendix A, Table A.2-29, for many LSs, the conditional probabilities of an oil spill will contact a certain LS within 30 days in the summer range in the single digits for the west side of the Kenai Peninsula, to 10% to 15% for LSs bordering Kamishak Bay in southwest Cook Inlet, and up to 17% for Chinitna Bay on the western side of Cook Inlet.

Oil from large spills has the highest chance of contacting ERAs on the western and southern sides of Cook Inlet for whales (ERAs 72 and 104) and pinnipeds (ERAs 11 to14 and 17) (Tables 4.3.2-14 and 4.3.2-15). Commercial fish species from the western and southern portions of Cook Inlet, including Kamishak Bay, and the Barren Islands, potentially affected by oil spills are adult anadromous fishes and eulachon transiting lower Cook Inlet; migrating juvenile salmon entering Cook Inlet from natal rivers and streams; herring, true cod, and halibut; and walleye pollock in the vicinity of Cape Douglas.

Appendix A, Table A.2-4, provides insight into areas with a high percent chance of contact based on a large spill occurring in a particular LA or PL. For example, a large spill originating in PL 3 has an estimated 97% chance of contacting South Cook HS 1b, Upper Kamishak Bay (ERA 13) within 30 days; a large spill originating from PL 4 has an estimated 97% chance of contacting Outer Kachemak Bay (ERA 145) within 30 days.

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. The relatively low percent chance of one or more large spills occurring and contacting various environmental resources is illustrated by examination of the highest combined probabilities. As shown in Appendix A, Table A.2-61, for many ERAs, the highest combined probabilities of a large oil spill occurring and contacting the west side of Cook Inlet within a 30-day range is 11% to 14%. The combined probability of one or more large spills occurring in contacting Outer Kachemak Bay (ERA 145) within 30 days over the life of the Proposed Action is 10%. All other areas had combined probabilities of <10%. Impacts of a large spill on commercial fishing are anticipated to be long lasting and widespread, and thus moderate.

Potential Impacts by Species

Shellfish

If a large oil spill occurred during a shellfish fishing season, the Cook Inlet commercial shellfish industry is likely to be affected by closures. Such a spill likely could affect shellfish in nearshore subtidal and intertidal areas but not those in deeper waters where oil residues seldom reach (Laevastu et al., 1985).

The Cook Inlet commercial shellfish industry would likely be affected by closures because shellfish in nearshore subtidal and intertidal areas are likely to be contacted. Fisheries for shellfish that occur in deeper waters seldom contaminated by oil residues are less likely to be closed. For example, weathervane scallop beds that are commercially harvested off Augustine Island in 38 to 115 m (125 to 377 ft) of water are unlikely to be damaged by an oil spill that passes through the proposed Lease Sale Area because oil concentrations at those depths likely would be too low to cause direct effects. In all likelihood, their depth would serve to segregate them from direct impacts associated with a floating oil slick at the sea surface. Regardless, even shellfish from deeper areas could become commercially unacceptable for market due to actual or perceived contamination and tainting. Actual contamination is possible; however, the likelihood is regarded as low, in part due to the large water exchanges that occur as part of the dynamic hydrography of Cook Inlet.

Groundfish

Fisheries for groundfish (i.e., rockfish, flatfish (including halibut), Pacific cod, lingcod, sablefish, Pollock) occurs in deeper waters where oil residues seldom reach are less likely to be closed in the case of a large oil spill. For example, halibut that are commercially fished in Cook Inlet, occurring between 50 and 500 m (164 to 1,640 ft) of water, are unlikely to be damaged by an oil spill. The spill would pass through the area and would be unlikely to impact groundfish because oil concentrations at those depths likely would be too low to cause direct effects. In all likelihood, their depth would serve to segregate them from direct impacts associated with a floating oil slick at the sea surface. Regardless, groundfish could become commercially unacceptable for market due to actual or perceived contamination and tainting. Actual contamination is possible; however, the likelihood is regarded as low, in part due to the large water exchanges that occur as part of the dynamic hydrography of Cook Inlet.

Lines from longline fisheries for halibut, Pacific cod, black cod, and other fish species could be affected by oil. Some lines and buoys fouled with small amounts of oil could be unfit for future use. Although it is unlikely that a trawler would be operating in an oiled area, the trawl catches could be contaminated by oil and rendered unfit for consumption if the trawler did pass through such an area.

Pelagic Fish

A large oil spill during the summer or fall seasons may result in the greatest impact to pelagic finfish (e.g., salmon) because this is when many pelagic migratory finfish are most abundant and have eggs and juvenile stages in the central Gulf of Alaska. Eggs and fry of some bentho-pelagic and demersal fishes may suffer lethal and sublethal effects from oil contact. These fish species’ life stages would be more easily affected because of their sensitivity and their inability to avoid oil. A large oil spill may cause local pelagic fish stocks or subpopulations to decline in abundance, requiring multiple generations for the impacted stock or subpopulation to recover to its former status. Although a single large spill may cause declines in subpopulations of multiple species inhabiting the proposed Lease Sale Area, they are not expected to cause a measurable decline in abundance requiring three or more generations for the indicated population of the central Gulf of Alaska to recover to its former status.

A large spill impacting subtidal and intertidal habitats would have long lasting and widespread and thus moderate impacts on fish and shellfish important for commercial fishing, resulting in lethal and sublethal effects on forage fish and intertidal species. Local populations of nearshore fish and shellfish would be measurably depressed for about a year, and small amounts of oil could persist in shoreline sediments for a decade or more. However, the spill effects would likely be limited to the subpopulation-level for pelagic fish in Cook Inlet.

Large oil spills could contaminate gear used for commercial fishing such as purse seines and driftnets. A large oil spill before or during the season when such fishing gears are in use could result in closures of high-value commercial fisheries to protect gear or harvests from potential contamination. As with the other fisheries, an oil spill could damage drift-gillnet gear (primarily floats and float lines) and result in possible widespread fishing closures.

The bays and beaches of Cook Inlet have a number of setnet sites where gillnets are anchored to the beach or slightly offshore, and are used to harvest salmon and herring. These operations could be affected by large oil spills. Large oil spills could damage setnet fisheries, as evidenced by the Exxon Valdez Oil Spill of 1989. Relatively small volumes of weathered oil entered lower Cook Inlet, but the commercial salmon fishery was closed to protect gear and harvest from possible contamination.

Under the Proposed Action, a 5,100-bbl large spill in Cook Inlet would likely result in large areas being closed to commercial fishing until cleanup operations or natural processes reduced oil concentrations in fishery areas to levels considered safe. Closures could be for one or more fishing seasons.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations.

Pelagic fishes important for commercial fishing may be affected by mechanical recovery of spilled material, but are expected to avoid an oiled area and to move away from vessels and booms or skimmers. If spill response activities are occurring during spawning runs, some fish could experience difficulty reaching their spawning grounds. These avoidance impacts of pelagic fishes would be short-term and localized to the spill area and thus minor. Benthic fishes and shellfish would not likely be affected by mechanical spill recovery activities occurring at the surface. The effects of mechanical recovery on benthic fish and shellfish resources would be negligible.

In-situ burning of spilled oil is used to remove oil from the surface and would impact fish and shellfish in the immediate area due to increased water temperature and residue from the burn sinking to the bottom. Death of pelagic fishes that did not move away from the spill is possible in the immediate burn area. Residue from a burn can sink and smother benthic fish and shellfish. These effects are expected to be short-term and localized to the immediate burn area, and would be considered minor.

The use of dispersants could result in impacts on plankton communities. Ramachandran et al. (2004) suggested that the use of oil dispersants will increase the exposure of fish eggs and larvae to hydrocarbons in crude oil. This has particular importance if dispersants are used while outmigrating salmon are present in the area. Dispersed oil could have toxic effects to benthic fish communities used in the commercial fishery.

These effects could be long-lasting and widespread for commercially harvested fish and shellfish if a large spill occurs, while a small spill would be more localized and short-term. Effects are unlikely to be population-level, though, as fish can avoid areas of spilled oil, and benthic community impact on shellfish would be limited spatially by the settling of oil and dispersant. Depending on the size of the spill and the time of year, use of dispersants could have minor (small spill) to moderate (large spill) effects on fish and shellfish used for commercial purposes.

Increased vessel traffic would add noise to the environment, and would increase the chance of small discharges from response vessels. Effects to fish and shellfish would have negligible impact on commercially harvested fish. Increased vessel traffic could cause space-use conflicts with commercial fishing vessels and closures on commercial fishing areas and seasons could prevent fishing. An important mitigation measure that can be considered is to involve commercial fisherman in spill consultation and spill response and cleanup activities.

Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread. Impacts of spill response and cleanup activities on commercial fisheries in Cook Inlet could range from minor to moderate.

4.3.11.7. Impact Conclusions

It is anticipated that routine operations would not result in population-level effects on commercial fishery resources in Cook Inlet. Temporary displacement of fishery resources from localized areas could occur as a consequence of noise and activities associated with construction during development; however, these fishery resources would be expected to return once construction disturbances have been terminated. Following platform construction, there could be some highly localized but long-term changes in fish densities and species diversity in the vicinity of platforms due to attraction of some invertebrate and fish species, which could be beneficial to both fish and commercial fisheries. The physical presence of production platforms near riptide locations could have a localized but long-term impact on the drift gillnet fishing industry. However, as a whole, it is likely that commercial fishers would be able to use alternative fishing grounds during times of space-use conflict. Therefore, commercial fishers are not expected to experience widespread losses or disruptions in their catches or operations as a result of routine operations. Consequently, the overall effects of routine activities on commercial fishing are anticipated to be **minor**.

The level of effects from small spills would depend on the location, timing, and volume of spills; spill response and cleanup activities; and other environmental factors. Small spills that may occur under the Proposed Action are likely to have a short-term and localized effect on commercial fishing before dilution and weathering reduced concentrations of oil in the water. Consequently, it is anticipated that small spills would have **minor** effects on commercial fisheries in Cook Inlet.

Large spills (up to 5,100 bbl) that may occur under the Proposed Action would likely have long lasting and widespread effects on pelagic fishes that are important for commercial harvest and sale, including several species of Pacific salmon. This would especially be the case if important habitat areas were to become contaminated from a large oil spill. Therefore, as a consequence of reduced catch, loss of gear, and/or loss of fishing opportunities for an entire season or more and during cleanup and recovery periods, the overall effects of a large spill could result in **moderate** impacts to commercial fishing in Cook Inlet. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for commercial fishing for routine activities or accidental spills. Also, GUIE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for commercial fishing with regard to routine activities.

4.3.12. Subsistence Harvest Patterns

IPFs that could impact subsistence harvest patterns include (1) seafloor disturbance and habitat alteration; (2) drilling discharges; (3) other operational discharges; (4) noise; (5) physical presence, including lights; (6) trash and debris (including non-hazardous domestic waste); (7) vessel traffic; (8) aircraft traffic and noise; (9) cuttings transport and disposal; (10) accidental oil spills and gas releases; and (11) onshore support activities. Direct and indirect effects on subsistence harvest patterns from routine and non-routine events, as described in Section 4.2.14, are discussed in this section.

Subsistence harvest patterns are affected in varying degrees by multiple IPFs throughout all four phases of the E&D Scenario. Some IPFs such as noise, seafloor disturbances, and drilling cuttings and discharges are greater in duration and extent during the E&D Scenario phases. Other IPFs such as trash and debris, the physical presence of oil and gas production facilities and supporting infrastructure, and routine operational disturbances (e.g., aircraft flights, vessel traffic) are greater during the production phase because that phase is longer lasting.

Subsistence harvest patterns may be directly or indirectly impacted by changes to the quality, quantity, distribution, or abundance of biological resources, or by changes in air or water quality that affect the biological resources harvested by subsistence users. Effects on subsistence harvest patterns may occur during all four phases of the Proposed Action (exploration, development, production, and decommissioning).

Subsistence harvests of wildlife resources, including personal use fisheries, are fundamental to many communities in Cook Inlet, Kodiak Island, and the lower Alaska Peninsula (see Section 3.3.3). These harvests provide not only important food resources, but also form the basis of core community values and cultural identity. Effects on subsistence harvests may lead to changes in sociocultural systems and community health, and can also be an issue with respect to environmental justice. Sociocultural systems, community health, and environmental justice communities are discussed further in Sections 4.3.13, 4.3.14, and 4.3.20, respectively. This section summarizes IPFs that may affect subsistence harvest patterns or the various species used for subsistence. More detailed and technical analysis of these impacts is contained in the biological sections addressing effects on various species and habitats, including birds, mammals, fish, and lower trophic organisms.

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.

4.3.12.1. Seafloor Disturbance and Habitat Alteration

Direct effects to subsistence harvest patterns from seafloor and habitat disturbance may occur during the migration season for Pacific salmon species during the construction phase. Subsistence harvest disruptions might occur as a result, causing changes in subsistence harvest productivity or making subsistence resources unavailable. Other subsistence species that might be disturbed could include crabs, shellfish, and subsistence species dependent on them as part of the food chain. Indirectly, the unavailability of subsistence resources, including salmon, may cause changes in individual and community well-being, health, and transmission of cultural knowledge and practices. Once pipeline construction is complete, direct impacts are short-term and localized in the places where well drilling, and buried or anchored pipelines are placed. The exploration, development, and decommissioning phases may have greater impact than the production phase when seafloor and habitat disturbance occurs as facilities are constructed during exploration and development, and removed or plugged and abandoned during decommissioning. Seafloor disturbance and habitat alteration are not expected to affect subsistence resources, including salmon, or disrupt subsistence harvest patterns. Many of the subsistence species are migratory. Disturbances to migratory subsistence resources could be mitigated by conducting these routine activities when the migratory species were not present.

4.3.12.2. Drilling Discharges

Direct effects to subsistence harvest patterns from drilling discharges may occur during exploration, development, operations, and decommissioning. Subsistence resource distribution, quantity, quality, or perceived quality may be affected by the presence of drilling discharges. Consequently, subsistence harvest patterns could be disrupted by harvesters' self-imposed restrictions from harvesting resources perceived to be tainted, or management agencies could impose harvest limits or limit harvest quantities, periods, or areas in the vicinity of drilling discharges. Indirect effects to subsistence harvest patterns may come from the accumulation of drilling fluids and cuttings, and resulting changes in the quality, quantity, or distribution of available subsistence resources. Effects of drilling discharges are expected to be short-term and localized, and thus minor. Industry could avoid or minimize impacts to subsistence harvest patterns by not discharging drilling materials.

4.3.12.3. Other Operational Discharges

NPDES permitting would regulate the operational discharges to prevent, minimize, or mitigate the intentional discharge of effluents into Cook Inlet. Direct effects to subsistence harvest patterns from operational discharges may occur during any of the four phases of exploration, development, operations, and decommissioning. Although there is a possibility that subsistence resource distribution, quantity, quality, or perceived quality may be affected by the presence of the operational discharges, this is unlikely given the historical and continuous presence of offshore oil rigs in the vicinity of the forelands, and the presence of offshore exploration drilling in the vicinity of Stariski Creek south of Ninilchik. Subsistence harvest patterns could be temporarily disrupted by harvesters' self-imposed restrictions from harvesting resources due to perceptions that resources could be tainted. Management agencies could impose harvest limits or limit harvest quantities or periods or areas in the vicinity of major operational discharges. Indirect effects to subsistence harvest patterns may come from the accumulation of operational discharges and resulting changes in the quality, quantity, or distribution of available subsistence resources. Effects to subsistence harvest patterns from operational discharges are expected to be short-term and localized, and thus minor.

4.3.12.4. Noise

Noise, including active acoustic sound sources, drilling and equipment noise, and vessel and aircraft noise, will be produced during the exploration, development, operational, and decommissioning phases of work in the proposed Lease Sale Area.

Direct impacts to subsistence resources from noise may result in altered distributions of those resources, and as a consequence, the altered availability of the resources to subsistence harvesters. Indirectly, subsistence harvesters in areas other than Cook Inlet may increase harvest efforts to provide resources to share with subsistence users whose harvests have been diminished by oil and gas activities in the proposed Lease Sale Area. Noise may impact subsistence harvest patterns by temporarily displacing or deflecting subsistence resources.

Noise from routine activities is expected to cause negligible to minor impacts to important fish species used for subsistence purposes.

Marine mammals are especially susceptible to underwater noise. Indirect effects from underwater noises may be that subsistence harvesters need to alter their locations, timing, or levels of effort to harvest the amounts necessary for subsistence. Marine mammals may be most affected, and consequently not be available at traditional harvest locations or at times when subsistence hunting occurs. For endangered species such as the Cook Inlet beluga whale, additional noise impacts may delay the eventual population recovery, thus further delaying the time when a subsistence harvest might be allowed to resume. IPFs from routine activities in the Proposed Action are expected to have a minor effect on marine mammals used for subsistence purposes, primarily resulting from anthropogenic noise and vessel traffic that would occur as a result of the Proposed Action.

Overall, noise impacts to subsistence harvest patterns are expected to be short-term and localized, and thus minor. Industry and subsistence harvesters can enter into formal agreements to delineate how to best avoid or minimize operational noise impacts to marine resources that are important to subsistence harvesters. Formal agreements designed to reduce effects require effective communication practices and relationship building to be successful (SRB&A, 2013).

4.3.12.5. Physical Presence, Including Lights

Direct impacts to subsistence harvest patterns from the physical presence of oil and gas -related infrastructure may be the altered distributions of subsistence resources, and as a consequence, the altered availability of the resources to subsistence harvesters. As with the indirect effects from noise or operational and other discharges, the indirect effects from the physical presence of oil and gas infrastructure may prompt subsistence harvesters to alter their locations, timing, or levels of effort to harvest the amounts necessary to carry on subsistence traditions. Impacts to subsistence harvest patterns from physical presence and lighting associated with routine operational activities are expected to be short-term and localized.

4.3.12.6. Trash and Debris (Including Non-hazardous Domestic Waste)

Direct impacts to subsistence harvest patterns from trash and debris are not expected to occur provided that all trash and debris are returned to shore for disposal at municipal solid waste sites. Construction of any new solid waste sites necessitated by any phases of oil and gas exploration and development would be done in compliance with existing regulations, planning, and mitigation measures with a negligible impact to terrestrial subsistence resources. Impacts to subsistence harvest patterns from trash and debris are expected to be negligible.

4.3.12.7. Vessel Traffic

Vessel traffic in Cook Inlet will increase in the proposed Lease Sale Area during all phases of the Proposed Action. Vessels involved in offshore oil and gas exploration activities would operate out of shore bases such as Kenai, Nikiski, Homer, or Anchorage. Ports and shore bases provide berthing spaces, fuel and supplies, and marine products and support services. Barges, seismic survey vessels, and supply vessels will operate during various phases of E&D Scenario; the estimated number of trips for each vessel type and for each phase is presented in the E&D Scenario.

Direct impacts to subsistence harvest patterns from the increase in vessel traffic during all E&D Scenario phases may be the altered distributions of migratory subsistence resources, for example, sea mammals used for subsistence may deflect from traditional harvest areas in reaction to noise from vessel traffic and be temporarily unavailable for harvest or exhibit skittish behavior resulting in challenging harvest circumstances. As a consequence, the availability of the resources to subsistence harvesters could be altered. Subsistence harvesters may need to temporarily alter their locations, timing, or levels of effort to harvest the amounts necessary to carry on subsistence practices. Impacts to subsistence harvest patterns from vessel traffic associated with routine operational activities are expected to be short-term and localized. Mitigation measures could include routing vessel traffic a specific distances from Alaska Native villages and traditional hunting and fishing areas. Industry and subsistence harvesters could enter into formal agreements to delineate measures to best avoid or minimize conflicts between operational vessels and subsistence harvest practices. Formal agreements designed to reduce effects require effective communication practices and relationship building to be successful (SRB&A, 2013).

4.3.12.8. Aircraft Traffic and Noise

Direct impacts to subsistence harvest patterns from the increase in aircraft traffic and noise during all phases include the altered distributions of subsistence resources, and as a consequence, the altered availability of these subsistence resources to subsistence harvesters. Subsistence harvesters may need to alter their locations, timing, or levels of effort to harvest the amounts necessary to carry on subsistence traditions. Impacts to subsistence harvest patterns from aircraft traffic associated with routine operational activities are expected to be short-term and localized.

The FAA provides guidance for aircraft operators to maintain altitudes of 610 m (2,000 ft) over noise sensitive areas such as national parks, wildlife refuges, and wilderness areas. This guidance is advisory only, and pilots-in-command may fly at any altitude required for the safe operation of flight. Typically, helicopters operate over Cook Inlet at altitudes below 305 m (1,000 ft) to avoid conflicts with fixed-wing aircraft operating at higher altitudes. Industry and subsistence harvesters could work to implement better helicopter and airplane management in the proposed Lease Sale Area. Industry could improve communication with local community organizations regarding flying activities. Aircraft operators could avoid areas of high subsistence use during peak harvesting seasons. One mitigation measure could be to formalize existing altitude restrictions or increase minimum flight altitudes in discussions with subsistence harvesters in each community. Another mitigation measure could include direct communication in the months in which subsistence harvests occurs with each community prior to take-offs and landings to identify if and where specific subsistence harvests are underway to reduce adverse effects to subsistence practices from the operation of aircraft. Communication centers could be organized to facilitate these mitigation measures and permit stipulations for aircraft activities can be proposed.

4.3.12.9. Cuttings Transport and Disposal

NPDES permits would prohibit discharging drilling fluids and cuttings during development drilling. Barges may be used to transport rock cuttings from production wells to onshore disposal facilities, if they are not reinjected offshore. Barges would make one to two trips per week from drilling locations to existing onshore disposal facilities. Depending on the volume of cuttings, one new additional disposal facility might be needed. BOEM estimates that production drilling could last up to 7 years, and based on 1 to 2 barge trips per week, could result in a total of 364 to 728 barge trips. Barge trips would produce air emissions and vessel traffic.

Direct impacts to subsistence harvest patterns from the increase in vessel traffic during all E&D Scenario phases include the altered distributions of subsistence resources, and as a consequence, the altered availability of the resources to subsistence harvesters. Subsistence harvesters may need to alter their locations, timing, or levels of effort to harvest the amounts necessary to carry on subsistence traditions. Mitigation measures could include identification of existing onshore disposal facilities, ensuring that existing facilities are not within or contiguous to Alaska Native villages or their lands, and adoption of mitigation measures outlined in Section 4.3.12.7, Vessel Traffic. Impacts to subsistence harvest patterns from transport and disposal of cuttings and drilling fluids associated with routine operational activities are expected to be short-term and localized.

4.3.12.10. Onshore Support Activities

Lease Sale 244 development activities such as onshore pipeline construction and siting through wetlands and streams (see Section 4.2.12) could cause short term and localized disruptions to local subsistence harvest patterns if the pipelines were sited near small towns and villages. This would particularly be the case for smaller subsistence-based communities in the Cook Inlet region if pipelines were placed in or near traditional hunting and fishing grounds. If pipeline construction, trenching, and burial temporarily blocked access to subsistence harvest opportunities on Federal, state, or tribal lands, subsistence harvesters could experience minor impacts to their patterns of harvest of terrestrial mammals, fish, and vegetation. However, onshore support activities are not expected to produce impacts to marine mammals (Section 4.3.6) and fish and shellfish (Section 4.3.5), two important groups of species for subsistence harvesters in the proposed Lease Sale Area. Moreover, onshore support activities are anticipated to have negligible effects on terrestrial mammals (Section 4.3.7) and only minor effects on birds (Section 4.3.8), which are also important for subsistence. Industry and subsistence-based communities or tribal governments can enter into formal agreements that specify how to avoid conflicts between onshore support activities and subsistence practices. Formal agreements designed to reduce effects require effective communication practices and relationship building to be successful (SRB&A, 2013). Pipeline siting can be conducted in a manner that avoids or minimizes disruptions to salmon streams and migratory bird nesting areas to protect subsistence species.

4.3.12.11. Accidental Oil Spills and Gas Release

Potential accidental spills include small (<1,000 bbl) diesel fuel spills, small crude spills, small condensate spills, refined fuel spills, and large oil spills/gas release (≥1,000 bbl) as described in Section 4.2.14. These non-routine events are discussed in terms of two general activity categories: (1) exploration and delineation; and (2) development, production, and decommissioning.

Small Oil Spills (<1,000 bbl)

Small oil spills and crude oil and condensate spills may occur directly from platforms, MODUs, or ruptured pipelines. Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours. Small spills of crude oil will persist longer in the environment and could result in more adverse impacts than spills of refined products. Platform spills and pipeline spills are assumed to occur in BOEM scenarios. Small spills would be geographically limited (i.e., localized) and impacts would be temporary because they are expected to evaporate before contacting shore. Impacts to subsistence harvest patterns from small spills are expected to be short-term and localized, and thus minor.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large spill of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours. A large spill of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products.

Traditional harvest locations may have resources deflected due to oiling of the environment, or resources may not be available in sufficient quantities to satisfy traditional harvest patterns. Spill response and cleanup activities may interfere with or disrupt subsistence harvest patterns. This could occur due to the implementation of emergency regulations that create exclusion zones to protect cleanup work areas, or prohibit subsistence harvests in certain areas.

Impacts to subsistence harvest patterns from a large oil spill include direct mortality of targeted subsistence resources, their prey, displacement of subsistence resources making them unavailable or more difficult to access for subsistence harvesters, and degradation of subsistence resource habitats used for migration, resting, spawning, foraging, rearing, and reproduction. These impacts could disrupt subsistence practices for one or more harvest seasons. For example, Sections 4.3.4 and 4.3.5 describe how impacts to important marine invertebrates, fish, and shellfish used for subsistence purposes would be long lasting and widespread due to large oil spills. Impacts to marine mammals from a large crude oil spill are expected to be long lasting and widespread due to large amounts of oiling of extensive areas of habitat.

Actual tainting (contamination), or the concern about tainted subsistence foods may (1) severely affect harvesters decisions about the level of effort placed into harvesting resources, (2) severely limit people's consumption of subsistence products, (3) cause people to completely stop eating traditional subsistence resources entirely for varying lengths of time following a spill event, and (4) cause severe psychological distress among subsistence harvesters. Subsistence resources may be deflected from traditionally accessed harvest locations nearshore and at shoreline or be completely unavailable in sufficient quantities to satisfy traditional harvest patterns.

For example, the ADFG Division of Subsistence updated information about subsistence uses in 15 communities affected by the Exxon Valdez Oil Spill including six Kodiak Island Borough communities in 2003 and 2004 (Fall, 2006). In total, people in 544 households were interviewed. Most households used, harvested, and shared wild foods. Approximately half the households reported lower total subsistence uses than before the spill, and 39% blamed spill effects for continuing lower uses of at least one resource. Many respondents reported increased effort to harvest resources due to scarcities and competition. Concerns were identified in eight study communities; these were related to paralytic shellfish poisoning, which was linked to the effects of Exxon Valdez Oil Spill, and inhibited marine invertebrate harvesting. Overall, 72% of respondents said that the traditional way of life had not recovered from the spill.

Impacts caused by large spills are expected to be severe, and thus major for subsistence harvest patterns and traditional practices.

BOEM estimates that a well control incident of a single well could occur under the Proposed Action that results in the release of 8 MMcf of natural gas in one day. A well control incident and possible explosion and fire could have impacts on subsistence resource (i.e., fish, birds, beluga whales) in the immediate vicinity of the blowout. Blowouts of natural gas condensates that did not burn would disperse rapidly at the blowout site; thus, it is unlikely that toxic fumes would affect subsistence resources except those very near the blowout site. A natural gas release of this size is expected to have short-term and localized effects on subsistence harvest patterns in the proposed Lease Sale Area.

Oil-spill Risk Analysis

Subsistence resources in Cook Inlet and the surrounding region are represented in the OSRA model by ERAs, LSs, and GLSs listed in Table A.1-11 of Appendix A. A summary of the highest percent chance that a large oil spill will contact subsistence resources within 3 and 30 days during summer and winter is provided in Table 4.3.2-26.

Table 4.3.2-26. Highest Percent Chance of a Large Oil Spill Contacting Subsistence Resources[1]

OSRA Feature Type	Highest Percent Chance	Summer		Winter	
		3 days	30 days[2]	3 days	30 days[2]
Environmental Resource Area (ERA)	≥0.5–<6	2 (Tyonek North)	2 (Tyonek North), 7 (Larsen Bay), 8 (Karluk), 9 (Akhiok)	--	7 (Larsen Bay), 8 (Karluk), 9 (Akhiok)
	≥6–<25	4 (Seldovia, Port Graham, Nanwalek)	5 (Port Lions), 6 (Ouzinke)	3 (Tyonek South), 4 (Seldovia, Port Graham, Nanwalek)	3 (Tyonek South), 5 (Port Lions), 6 (Ouzinke)
	≥25–<50	3	3 (Tyonek South), 4 (Seldovia, Port Graham, Nanwalek)	--	4 (Seldovia, Port Graham, Nanwalek)
Grouped Land Segment (GLS)	≥0.5–<6	--	116 (Chignik, Chignik Lagoon)	--	--

Notes: -- all percent chances of contact are <0.5.
[1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5 are shown.
[2] Note that the highest percent chance contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.

Source: Appendix A (Tables A.1-11, A.2-22, A.2-24, A.2-27, A.2-29, A.2-32, A.2-34, A.2-42, A.2-44, A.2-47, A.2-49, A.2-52, and A.2-54). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

In a summer or winter spill event, the subsistence harvest areas used by Tyonek, Seldovia, Port Graham, and Nanwalek harvesters could be affected within 3 days. After 30 days in summer, those four communities plus the communities of Larsen Bay, Karluk, Akhiok, Port Lions, Ouzinkie, and the Chigniks could be affected. After 30 days, a winter spill could affect all of these same communities, except the Chigniks. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations.

If clean-up operations include sections of the beach, or intertidal zones, access to subsistence fishing and shellfishing areas and areas used for coastal hunting of terrestrial mammals could be temporarily restricted.

Subsistence harvest patterns could be adversely affected by spill response and cleanup activities that involved volunteer or paid employment of subsistence harvesters, by diverting time, effort, and equipment away from subsistence activities to oils spill response and cleanup activities. Earning cash from paid work in spill response and cleanup activities may allow some subsistence harvesters to purchase newer equipment and fuel needed to effectively pursue subsistence activities.

Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time could be short-term and localized or long lasting and widespread.

Offshore mechanical recovery methods are not expected to impact subsistence harvest patterns. The use of chemical dispersants and in-situ burning would most likely result in perceptions of environmental contamination and tainting of subsistence resources that could last for one harvest season or longer. Perceptions of contamination and actual contamination of resources could result in deflection or cessation of subsistence harvest of marine resources.

Impacts to subsistence harvest patterns caused by spill response and cleanup activities are expected to be minor to moderate depending on the extent and location of the spill.

4.3.12.12. Impact Conclusions

Short-term access to subsistence resources and localized hunting areas could be affected by reductions and changes in the distribution of important subsistence resources such as fish and shellfish and other marine invertebrates (Section 4.3.5) and marine mammals (Section 4.3.6). These changes could occur as a result of the IPFs associated with routine activities discussed earlier, individually or in various combinations. Overall, the effects of routine activities on subsistence harvest patterns are expected to be **minor** because these would most likely be short-term and/or localized and less than severe.

Impacts from small spills would be localized, short-term, less than severe, and thus are expected to be **minor** for subsistence harvests patterns.

The OSRA model estimates that if a large oil spill occurred, oil could contact subsistence use area ERAs (or LSs or GLSs) within 3 or 30 days. While regional and statewide benefits to Alaskans and the economy may come from OCS oil and gas development, the adverse effects of a small or large spill event would be disproportionately felt by rural residents, predominantly Alaska Natives, living off the road system and practicing a subsistence way of life. This includes the communities at Tyonek, Seldovia, Port Graham, and Nanwalek in the Cook Inlet region; Kodiak Island communities; and southern Alaska Peninsula communities.

Large spills could severely affect subsistence harvest patterns by reducing subsistence resources for long periods of time, contaminating subsistence foods, contaminating the marine environment, or rendering subsistence resources unusable. Effects that reduce the amounts of subsistence foods harvested cause changes in traditional diets and increase risk and wear and tear on equipment used for harvesting if harvesters are forced to travel farther distances to access subsistence resources. Disruptions to subsistence harvest patterns from large spills can cause severe social stress and anxiety from reduction or loss of traditional practices and cultural well-being and identity.

Impacts from a large spill of crude oil could cause severe and thus **major** effects to subsistence harvest patterns due to their potential to 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.

Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for subsistence harvest patterns for routine activities or small and large accidental spills. Also, GIUE (e.g., oil spill drills), which are infrequent, of short duration, (<8 hours), localized and utilize existing equipment, would not alter impact conclusions for subsistence harvest patterns for routine activities.

4.3.13. Sociocultural Systems

IPFs that could affect sociocultural systems include (1) onshore support activities, (2) employment and project spending, and (3) accidental oil spills and gas releases.

4.3.13.1. Onshore Support Activities

Lease Sale 244 development activities could cause disruption to local sociocultural systems in small towns and villages, particularly in smaller communities in the Cook Inlet region. Kenai, Nikiski, and Homer, which are nearest to existing infrastructure and proposed onshore pipelines (see Section 4.2.12), may experience short-term and localized effects. Some disruption could result during development from the expansion of onshore infrastructure, with some long-term benefits to the Kenai Peninsula Borough resulting from additional real property taxes. The effect of any additional onshore infrastructure expansion, however, would be much less than the effect of the initial construction of the shore base facilities and infrastructure during the latter part of the twentieth century. While the initial construction of shore base facilities led to changes in the then-existing social patterns, those changes occurred prior to Lease Sale 244 development, and little to no further disruption of social patterns would be expected from expansion of onshore facilities.

4.3.13.2. Employment and Project Spending

One of the first MMS studies related to employment and project spending completed in the late 1970s focused on the lower Cook Inlet region. Braund and Behnke (1980) identified five sociocultural impact categories: economic adaptations, small town/village social relationships, land and environment, politics and response capacity, and social health (alcohol, substance abuse, mental health issues, and crime).

Potential effects to the economy could occur if the Proposed Action alters employment or income characteristics of the area, changes the demographics of the area, results in changes to the workforce, or otherwise affects the employment and economic opportunities of area residents. Although the Proposed Action is expected to provide revenues to the Kenai Peninsula Borough indirectly through employment, sales taxes, and general economic activity, substantive changes in local employment and income characteristics are not expected to occur. Short-term increases in local employment may occur related to oil and gas development and production activities. Historically, such employment opportunities, particularly as they translate into employment of Alaska Natives, have been insignificant; this is expected to continue. Though Alaska Native employment in oil-related jobs in Cook Inlet is currently low, Alaska Native leaders continue to push for programs and processes with industry to encourage more hires of Alaska Native peoples. In particular, hiring and employment practices that value and facilitate continued participation in subsistence activities would be valued by local residents. Increased employment opportunities would provide some economic benefits.

Small town/village social relationships are extended family and kinship-based in the predominantly Alaska Native communities. Family bonds are strong, and are further strengthened through kinship-based work groups and strong cultural values associated with harvesting, processing, sharing (giving/receiving) fish and wildlife resources. Any decrease in available subsistence foods could disrupt family kinship relations and sharing practices, as decreased activities reduce the need for cooperation and alter networks in which distribution of subsistence resources traditionally occur. Weakened family bonds would disrupt one of the main elements of cultural identity and self-worth, disrupting village life and threatening cultural values for those living a subsistence way of life.

The MMS study examined lower Cook Inlet local socioeconomic systems in the late 1970s with baseline and several possible development scenarios (Braund and Behnke, 1980). The land status on the Kenai Peninsula was in flux in the 1970s, as state and ANCSA land selections and Federal conservation unit lands progressed through Congress, agencies, and the courts. Real estate land speculation was widespread, as people purchased much of the available land in private markets. Forty years later, there is little public land (Federal, state, borough) that is not designated for some specific purpose through enabling legislation (i.e., national forests, parks, wildlife refuges) or state and local land use plans and zoning use classifications. Pressures on natural resources and the ongoing political battles over allocation of fish among users (i.e., sport, commercial, subsistence) continue with no resolution in sight. Competition for fish and wildlife resources will continue regardless of whether OCS activity occurs because more Alaskans are trying to harvest the available fish and wildlife resources. Deterioration of the Kenai River watershed and streambank habitat has been halted and perhaps reversed by concerted political activity and conservation pressures to control streamside development (e.g., docks, piers, erosion control measures) and harvest practices (e.g., outboard motor horsepower limitations, open periods, bag limits).

Potential effects on institutional organizations could occur if the Proposed Action affects how institutions are structured or how they are able to function to provide services and foster community stability. The Proposed Action would represent a continuation of routine and maintenance activities related to operation of any new or existing platforms, shore bases, and pipelines. Continuation of these activities is not expected to require changes to the larger communities or Kenai Peninsula Borough services. Local employment would stabilize population and density; it would also slow the rate of decline and increase the stability of Kenai Peninsula Borough communities in the short term.

Adverse and minor effects on social wellbeing and cultural values could occur if the Proposed Action alters subsistence harvest patterns, known archaeological or cultural sites, or cultural continuity. Impacts from routine operations to subsistence harvest patterns are expected to be short-term and localized, and thus minor (see Section 4.3.12.11). No subsistence resource or harvest area is likely to become unavailable or undesirable for use in the long term because of routine operations or small accidental spills or gas releases, and no species used for subsistence would experience overall population reductions from Lease Sale 244 routine development and production activities.

4.3.13.3. Accidental Oil Spills and Gas Release

Accidental spills include small (<1,000 bbl) diesel fuel spills, small crude spills, small condensate spills, gas releases, refined fuel spills, and a large oil spill (≥1,000 bbl) as described in Section 4.2.14.

Small Oil Spills (<1,000 bbl)

Potential impacts from small spills of all kinds are not likely to cause sociocultural systems disruptions except as discussed in Section 4.3.12 for subsistence harvest patterns. Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and would be unlikely to affect sociocultural systems in the long term. Small spills of crude oil will persist longer in the environment and could result in more adverse impacts than spills of refined products but are expected to be short-term and localized.

Small spills may affect subsistence resources and other fish and wildlife resources and habitat used by community members. As discussed earlier, changes in sociocultural systems are occurring in communities throughout the proposed Lease Sale Area. These changes will continue to occur with or without the additional E&D Scenario phases that might occur following any lease sales. In subsistence-oriented communities, social organization based on kinship relationships will continue.

Effects on social health (cultural values) could occur if oil and gas development and production alter subsistence harvest patterns. In subsistence-oriented communities, traditional emphasis is on kinship, community, cultural continuity, cooperation, and sharing. Impacts to subsistence harvest patterns from small spills are expected to be short-term and localized, and thus minor. No resource or harvest area is likely to become unavailable or undesirable for use in the long term due to the various IPFs previously discussed, and no important subsistence species would experience overall population reductions from small spills.

If sustained harvest losses occur, the losses could result in disruptions to the food sharing and distribution patterns, in turn creating cultural stress and diminished nutritional status for some communities in the proposed Lease Sale Area. Accidental small spills may affect the aesthetic, cultural, and spiritual values of Alaska Native subsistence harvesters by causing short-term subsistence harvest disruptions, or by creating the perception of contamination. Perceived or actual contamination may result in the undesirability or inability to harvest and share subsistence foods within and outside communities.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large oil spill of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and would be unlikely to affect sociocultural systems. Large spills of crude oil will persist longer in the environment and could result in severe impacts to the marine environment, cultural values, and subsistence harvest patterns.

A large oil spill event would likely have effects on the sociocultural systems of communities in the proposed Lease Sale Area with the exact consequences depending on the size, timing, location, movement, and type of crude or refined product(s) spilled. The effects would be felt in three areas of sociocultural systems: social organization, cultural values, and institutions. For example, a large oil spill that affected salmon fisheries would have effects not only on subsistence and personal use harvests, but also on commercial and sport fisheries. The portion of the regional economy connected to healthy salmon populations would be disrupted, with effects on the people whose livelihood is connected to salmon. Kinship relations and commercial fishing crew organization would change to respond to diminished or prohibited salmon harvests as people compete for ever-scarcer resources. The cultural values placed on cooperation in fish harvesting, processing, sharing, and distribution could be severely impacted for one or more fishing seasons. Existing institutions are less likely to be affected by a large oil spill. Borough, city, and tribal governments would continue in the event of a large oil spill, but could take on additional roles to cope with spill response and cleanup activities. New institutions might form, as occurred with the emergence of Cook Inlet Keeper, a citizen coalition established in 1995 to address alleged violations of the CWA by oil companies operating in Cook Inlet.

For a large oil spill event, impacts on the smaller subsistence-oriented communities would likely be a greater disruptor to sociocultural systems than would be felt in larger, more heterogeneous communities less dependent on subsistence harvests. Sociocultural systems throughout the proposed Lease Sale Area could be affected in a positive or negative manner, depending on whether regional economic revenues accrue sufficient to change local demographics, employment opportunities, or community prosperity. It is equally as true today as it was in 1980 that “the dependence on marine resources (both commercial and subsistence) puts all of the (Cook Inlet) communities in a vulnerable position with regards to potential industrial accidents which could harm the marine environment” (Braund and Behnke, 1980).

BOEM estimates that a well control incident of a single well could occur under the Proposed Action, resulting in the release of 8 MMcf of natural gas in one day. A single day release of 8 MMcf of gas would not be expected to have long-term or widespread impacts on sociocultural systems.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island for up to 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time could be short-term and localized or long lasting and widespread.

Subsistence harvest, processing and sharing are the foundations of sociocultural systems in Alaska Native communities. If clean-up operations include sections of the beach, or intertidal zones, access to subsistence fishing and shellfishing areas and areas used for coastal subsistence hunting of terrestrial mammals could be temporarily disrupted by response and cleanup activities or restricted by regulators due to conservation and species recovery issues.

Offshore mechanical recovery methods are not expected to impact subsistence harvest patterns, social organization, local institutions, or cultural values. The use of chemical dispersants and in-situ burning would most likely result in perceptions of environmental contamination and tainting of subsistence resources that could last for one harvest season or longer. Perceptions of contamination and actual contamination of resources could result in deflection or cessation of subsistence harvest of marine resources.

Effects to social and institutional organizations can occur due to local employment in spill response and cleanup activities (USDOI, BOEM, 2015e). The sudden employment increase in spill remediation could have long lasting and widespread effects, including economic inflation and displacement of Alaska Native residents from their normal subsistence harvesting, processing, and distribution activities. Cleanup employment of local residents could place stresses on local village and town infrastructures by drawing away local workers from community service jobs. Immediate socioeconomic impacts may include: increased health care demands, increased crime rates, labor shortages, disruption of local government activities, and social conflicts between local residents and outsiders coming to town to work in spill cleanup jobs. The deterioration of social relationships, anxiety, and depression may result from long-term and widespread spill remediation, rendering routine stress-coping strategies ineffective at the local level (USDOI, BOEM, 2015).

Impacts to social patterns and organization, local institutions, and cultural values caused by spill response and cleanup activities are expected to be minor to moderate depending on the extent and location of the spill and to what extent subsistence harvest patterns are disrupted.

4.3.13.4. Impact Conclusions

Effects to sociocultural systems from routine activities associated with the Proposed Action are expected to be short-term and localized, and thus **minor**. Social systems are expected to successfully respond and adapt to the change brought about by the continuation of exploration and production activities.

Impacts to sociocultural systems from small spills are expected to be **minor** due to their limited geographic and temporal effects.

Impacts from a large spill of crude oil could be **major**, depending on the spill location relative to the resources impacted and the duration and extent to which impacts from a large spill disrupt subsistence activities and social organization. Impacts from a large spill would have an indirect and severely adverse effect on sociocultural systems if subsistence fishing and hunting, commercial fishing, and/or personal use salmon fishing were disrupted for one or more seasons (see Section 4.3.12.10, Large Oil Spill/Gas Release). Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for sociocultural systems for routine activities or small or large accidental spills. Also, GIUE (e.g., oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for sociocultural systems for routine activities.

4.3.14. Public and Community Health

This section provides an analysis of potential impacts of the Proposed Action and alternatives to public and community health by analyzing a framework of health determinants and health outcomes (see Section 3.3.5). This analysis uses the following terms related to health in the Cook Inlet region:

- Public Health is the science of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts for cleanliness of the environment, control of community infections, education of individuals about personal hygiene, the institutional organizations of medical and nursing services for early diagnosis and treatment of disease, and the development of social systems to ensure every individual in the community a standard of living adequate for the maintenance of health (Institute of Medicine, 2003; Winslow, 1920).
- Community Health is the health status of a defined group of people with diverse characteristics who are linked by the following elements:
    - Membership - a sense of identity and belonging
    - Similar language, rituals, and ceremonies
    - Shared values and norms
    - Mutual influence - community members have influence and are influenced by each other, shared needs and commitment to meeting them; and
    - Shared emotional connection - members share common history, experiences, and mutual support (Israel et al., 1994)

Community health activities are aimed at protecting or improving the overall health and well-being of a population or community.

The following sections discuss impacts associated with IPFs that could affect public and community health. Health can be impacted by disruptions of the interrelationship of subsistence hunts and sociocultural systems by affecting nutritional status and mental health of community members. For impact analyses to subsistence harvest patterns and sociocultural systems, see Sections 4.3.2.12 and 4.3.2.13. The primary IPFs affecting public and community health are (1) air pollutant and greenhouse gas emissions, (2) employment and project spending, and (3) accidental oil spills and gas releases.

Other impacts may come from population movement or displacement related to increases in non-local people coming to the area in search of employment opportunities. Local residents could be displaced from traditional social patterns or find themselves in competition for limited resources such as health and social services. Cultural values could be threatened by an influx of outsiders' values as they arrive and establish themselves in communities to work in the oil and gas industry. A population influx could affect communicable disease patterns, increase social stressors/tensions, and contribute to mental health problems, increased violence, alcohol consumption, and drug use.

Oil and gas development can generate positive benefits for health and health systems. Incorporation of primary prevention measures into community planning during development can contribute to wider achievement of public and community health goals and strengthen engagement between those conducting the health care work and local health systems.

Health indicators and outcomes would have the highest potential for change in the communities of Seldovia, Port Graham, and Nanwalek that have a larger proportion of Alaska Native peoples compared to other Cook Inlet communities, but effects could occur throughout the region. For this analysis, communities closest to the proposed Lease Sale Area –Nanwalek, Port Graham, Seldovia, Kachemak, Homer, Anchor Point, Ninilchik, Clam Gulch, Kasilof, Kalifornsky, Soldotna, Kenai, Salamatof, Nikiski, Tyonek, Hope, and Anchorage onshore – are the primary focus. Anchorage, Kenai, Homer, and Nikiski are the prospective shore base locations, so most impacts to public and community health would be expected in these communities. Increased overland or airborne transport to shore bases would affect the surrounding communities. However, all regions and communities, including those listed previously in the Kenai Peninsula Borough, with the addition of the upper Cook Inlet region, will be included in the analysis, because they are located in the proposed Lease Sale Area.

Effects to public and community health, through stressors such as air pollutants, can lead to pathologies due to such effects as changes in air quality. This in turn places stressors on local institutions by increasing burdens on the delivery of healthcare in the communities. The Centers for Disease Control and Prevention's (CDC's) Racial and Ethnic Approaches to Community Health (REACH) 2010 program (Figure 4.3.14-1) is an illustration of how IPFs and their resulting effects can be integrated into the public and community health model.

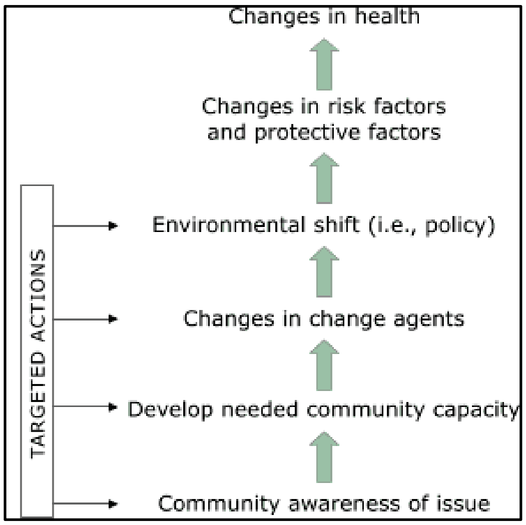

Figure 4.3.14-1. The Racial and Ethnic Approaches to Community Health (REACH) 2010. *Model of Change Adapted by the Southwest Center for Community Health Promotion.*

4.3.14.1. Air Pollutant and Greenhouse Gas Emissions

Ambient air pollution and greenhouse gas emissions would be the result of pollutant emission from diesel engines associated with vessel traffic, construction activities, and operation equipment in support of oil and gas activities. Survey vessels, drilling rig operations, production platforms, helicopters, and service vessels will emit air pollutants, mainly from combustion of diesel fuel. Well testing during the exploration phase, and venting and flaring during the development phase will result in combustion products. Air emissions may occur during treatment and disposal of SBF-wetted cuttings. Construction vessels and trucks, forklifts, cranes, and other hauling and lifting equipment used at the dock and onshore base will emit air pollutants.

All emissions of airborne pollutants during oil and gas activities on the OCS will increase concentrations to some extent in the region. However, due to the dispersion and mixing of pollutants in the atmosphere and regulations requiring the use of emissions control technology or equipment that meets air emissions standards, measurable impacts at the nearest air quality monitoring stations are expected to be temporary and minor. Air quality is not currently impaired in any adjacent boroughs that are in maintenance status for the criteria pollutant CO. The Proposed Action would not cause any of the boroughs to fall back into nonattainment status for any criteria pollutants (see Section 3.1.4.2). In terms of public and community health, air pollution will likely affect incidences of respiratory, cardiovascular, and chronic bronchitis-related hospital admissions in adults and children who are unusually sensitive to air pollution or who have asthma.

4.3.14.2. Employment and Project Spending

In evaluating the potential adverse effects from the Proposed Action to public and community health, possible disruptions from activities are expected to occur as a result of Lease Sale 244 and the changes occurring over the last 50 years as the normal results of historical oil and gas development onshore and offshore in Cook Inlet. Potential effects to the economy could occur if the Proposed Action alters employment or income characteristics of the area, changes the demographics of the area, results in changes to the workforce, or otherwise affects the employment and economic opportunities of area residents. BOEM expects direct employment and earnings, increased tax income for state and Federal taxing authorities, and population growth to be generated by the Proposed Action, although substantive changes in local employment and income characteristics are not expected to occur, as noted in Section 4.3.10, where overall effects to the economy would be minor. Short-term increases in local employment may occur; employment would vary with the phases of the E&D Scenario (see Section 4.2.13). Also, subsequent increases in population from employment are not anticipated to be large, so this should not impact healthcare delivery systems, particularly in smaller coastal villages, which was a concern in lower Cook Inlet during previous studies related to oil and gas activities (Braund and Behnke, 1980).

During shorter phases of the E&D Scenario (e.g., exploration), the impact on public and community health of increased direct employment of oil workers is expected to be short-term and localized. During production activities, the impacts of employment and project spending would be short-term and localized, and thus minor. These effects would have beneficial components, including indirect employment and increased tax income for state and Federal taxing authorities as noted in Section 4.3.13. Specifics about the multipliers calculated by the BEA are discussed in Owl Ridge Natural Resource Consultants, Inc. (2015). Based on these multipliers, the amount of indirect and induced employment (e.g., additional public health care jobs) is estimated to reach a maximum of 427 jobs in year 6 and remain at 99 jobs during production in years 14 to 40. Indirect and induced earnings are likewise estimated to peak in year 6 at $35 million and remain at $9 million per year during production (Owl Ridge Natural Resource Consultants, 2015).

Effects on institutional organizations that provide healthcare services and community health programs could occur if the Proposed Action affects how these institutions are structured or how they are able to function to provide services and foster community stability. Based on Section 4.3.13.4, community health should not be adversely affected as social systems, including local institutions, are expected to successfully respond and adapt to the changes brought about by the continuation of exploration, development, and production activities. Overall, effects of employment and project spending on community health are expected to be short-term and localized.

4.3.14.3. Accidental Oil Spills and Gas Release

Accidental oil spills, including small spills (<1,000 bbl) and a large spill (≥1,000 bbl), could occur from fuel transfer accidents, platform fuel tank ruptures, and well blowouts of gas from platforms, MODUs, and pipelines. The magnitude and extent of impacts on public and community health from such spills will be a function of a variety of factors, including the type and amount of spill, the location, and season.

Small Oil Spills (<1,000 bbl)

Small refined oil spills (<1,000 bbl), although accidental, are expected to occur during routine exploration, development, and production activities. Small spills may be contained on a vessel or platform, and spills reaching the water may be contained by booms or absorbent pads. Small refined oil spills can occur from vessel discharges, ruptured lines, seal failures, and human error while refueling.

Small refined oil spills primarily include 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 oil spills would persist for a shorter time than a crude oil spill of the same volume. Gasoline and diesel fuels contain substances such as benzene, toluene, and xylenes, which can enter the environment and cause adverse health effects. Other substances with the potential to impact health, such as 1, 3-butadiene and formaldehyde, are formed in engines during combustion and are only present in exhaust.

Effects to public and community health from small accidental spills occurring during routine operations are expected to be short-term and localized.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large spill during development activities could impact public and community health in the long term, be and widespread, and have moderate effects depending on the type and amount of oil spilled, the location, and the season. In the event of a large oil spill, subsistence harvest resources and the local environment would be affected due to contact with crude oil or condensate in addition to refined products, and could result in impacts to public and community health related to disruptions to subsistence practices. These include compromised nutrition and general decreases in community well-being due to a lack of traditional foods and inability to engage in traditional practices. Impacts of large oil spills to subsistence harvest patterns and sociocultural systems could be major and are presented in Sections 4.3.2.12.10 and 4.3.2.13.3, respectively.

Health consequences of a large oil spill to community members and oil workers are associated with vapors, PM from controlled burns, VOCs, PAHs, and heavy metals. Additionally, spill cleanup workers could face potential hazards from oil byproducts, dispersants, detergents, and degreasers. Drowning, heat illness, cold exposure, and falls pose hazards to oil spill response workers, as can encounters with wildlife native to the impacted areas.

A large oil spill could affect Cook Inlet communities due to toxic contamination or perceived contamination to air, water, soils, and subsistence harvest resources. In turn, this increases community stressors and decreases nutritional status by the use of packaged foods at a higher volume, or percentage of diet, than normal. Direct impacts to community members could occur when local community members work on cleanup and repair projects and must work with outside workers who may be unfamiliar with Alaska Native culture and who may bring illnesses and social conflicts to villages.

A growing body of evidence demonstrates the physical, mental, and community health effects of historical oil spills. Large oil spills can have long lasting and widespread and adverse but reversible impacts for community members living in the impact zone and spill response workers (i.e., resident and non-resident volunteers and paid professionals) engaged in cleanup efforts (Eykelbosh, 2014). There is some evidence of respiratory, endocrine, immunological, and genotoxic effects persisting for years in those more highly exposed to the spill and its resulting contaminants.

Researchers working on health impacts in Alaskan communities impacted by the Exxon Valdez Oil Spill in 1989 followed the mental health of oil-exposed populations over the long term. Studies found that community members showed changes in indicators of post-traumatic stress, including greater degrees of intrusive stress (e.g., recurrent, unprovoked, negative thoughts about the event) and avoidance behavior (e.g., suppression of thoughts/behaviors related to the event) (Picou et al., 1992). Although intrusive stress declined somewhat over time, it remained significantly elevated compared to the less-impacted control community 18 months after the spill, whereas avoidance behavior remained constant over time. These data indicate the presence of persistent psychological harm over time at the individual level.

In the event of a natural gas release, CH_4 and other greenhouse gases such as CO_2 and ethane would be released, and water quality would be altered temporarily, potentially affecting subsistence harvest patterns and indirectly affecting health. Most gas escaping and contacting water would dissipate quickly, producing negligible effects to public health. Upon reaching the surface, gaseous CH_4 would react with air, forming CO_2 and water, which would then disperse into the atmosphere. Impacts on public and community health from a gas release are expected to be negligible.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak

Island within 30 days, in the case of a large spill. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread.

Subsistence harvest, processing, and sharing are the foundations of sociocultural systems in Alaska Native communities and contribute substantially to community health and well-being. If clean-up operations include sections of the beach, or intertidal zones, access to subsistence fishing and shellfishing areas and areas used for personal use salmon fishing and coastal hunting of terrestrial mammals could be temporarily disrupted by response and cleanup activities or restricted by regulators due to conservation and species recovery issues. Disruptions to subsistence harvest practices due to spill response and cleanup could be long lasting and widespread for some communities in the proposed Lease Sale Area. This could cause moderate impacts to health for the communities most reliant on a subsistence way of life.

Offshore mechanical recovery methods are not expected to impact public and community health because this method of spill cleanup is not expected to affect subsistence harvest patterns, social organization, local institutions, well-being, or cultural values. The use of chemical dispersants and in-situ burning would most likely result in perceptions of environmental contamination and tainting of subsistence resources that could last for one harvest season or longer. Perceptions of contamination and actual contamination of resources could result in deflection or cessation of subsistence harvest of marine resources, personal use salmon fishing, or other important harvests, indirectly impacting health and well-being in the long term for most communities in the impact zone of a large oil spill.

Effects to community organization and capacity to provide public health services can occur due to local employment in spill response and cleanup activities (USDOI, BOEM, 2015e). The sudden employment increase in spill remediation could have long lasting and widespread effects, including displacement of Alaska Native residents from their normal subsistence harvesting, processing, and distribution activities. Cleanup employment of local residents could place stresses on local village and town infrastructures such as hospitals and health clinics by drawing away local workers from community service jobs or increased medical visits from outside spill cleanup workers (i.e., increased health care demands, increased crime and injury rates, increased social conflicts between local residents and outsiders). The deterioration of social relationships, anxiety, and depression may result from long-term and widespread spill remediation operations, rendering routine stress-coping strategies ineffective at the local level, contributing to compromised community health (USDOI, BOEM, 2015e).

Impacts to public and community health from spill response and cleanup activities are expected to be moderate depending on the extent and location of the spill and to what extent subsistence harvest patterns, local institutions, and community healthcare facilities are disrupted.

4.3.14.4. Impact Conclusions

The nature and magnitude of effects of routine operations in the proposed Lease Sale Area on public and community health in the Cook Inlet region would depend on the specific location, timing, nature, and magnitude of the operations involved in each phase of development and the proximity of sensitive receptor resources, and specific communities and residents that would be exposed to the effects of operations. The potential impacts to public and community health from routine activities under the Proposed Action would be expected to be greatest at the actual location of shore bases used for various operations for each phase of activity rather than at offshore locations.

Periods of exploration and construction activity would have a localized and short-term effect to communities due to increased emissions from increased operation of vessels and construction equipment and the influx of workers. Long-term operation of facilities would have associated air emissions over the life expectancy of these facilities. Impacts of air pollution and emissions from routine operations on public and community health are expected to be short-term and localized.

During shorter phases of the E&D Scenario (e.g., exploration), the impact on public and community health of increased direct employment of oil workers will be temporary and specific to those individuals and families who obtain employment in exploration. During production activities, the impact would be short-term and localized with beneficial components which include employment and increased tax income for state and Federal taxing authorities.

While most accidental spills would be small and would have short-term and localized on public and community health, large spills that reach coastal areas could have long lasting and widespread impacts, affecting a greater number of sensitive species important for subsistence practices, contaminating large areas of sensitive habitat, disrupting subsistence activities, threatening public and community health, and potentially requiring remediation. Impacts from large spills could result from oiling of the shoreline and mechanical damage during the cleanup process. A large spill could affect habitats along extensive areas of coastline and large numbers of sensitive species and important habitats (such as nesting colonies or wintering grounds).

Overall impacts to public and community health from routine operations under the Proposed Action are expected to be short-term and localized, and thus **minor**. In the case of small spills, impacts are expected to be **minor** because they will be short-term and localized. In the case of a large oil spill, impacts to public and community health could be long lasting and widespread, and thus **moderate**, depending on the size and location of a spill and whether or not impacts disrupt subsistence harvest activities for one or more seasons, alter local health care provision, disrupt traditional sharing networks, and/or threaten cultural values and identities. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for public and community health. Also, GIUE (e.g., oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for public and community health for routine activities

4.3.15. Recreation, Tourism, and Visual Resources

Impacts to recreation and tourism experiences and visual and scenic resources occur when the public enjoyment of a particular resource or viewshed is adversely affected by an activity or action that conflicts with individuals' desired or expected conditions. This may occur through an alteration of perceptions or through temporary or permanent changes to the landscape or other settings that are important for recreation and tourism. Adverse visual impacts can affect the quality of recreational experiences and settings important to Alaskan tourism. IPFs that could impact recreation, tourism, and visual resources include (1) physical presence, including lights; (2) trash and debris (including non-hazardous domestic waste); (3) vessel traffic; (4) aircraft traffic and noise; (5) cuttings transport and disposal; (6) onshore support activities; and (7) accidental oil spills and gas releases.

Visual impacts occur when the public enjoyment of a particular resource is adversely affected by an activity, through an alteration of visual perception or through temporary or permanent visual changes to the landscape. The Proposed Action will introduce a number of temporary and semi-permanent visual elements to the landscape.

4.3.15.1. Physical Presence, Including Lights

The physical presence of the offshore MODUs, platforms, supply vessels, and pipelines (e.g., at landfall) will result in a notable visual impact. Assuming a structure 61 to 76 m (200 to 250 ft) tall, most of the water and shoreline areas surrounding the proposed Lease Sale Area will have some level of project visibility during clear days and nights. Figure 3.3.6-2 demonstrates the extent of potential project visibility considering bare earth conditions. Based on this conservative scenario (analysis does not consider the screening by trees and structures), approximately 76% of the 32-km (20-mi) visual study area will have visibility of a platform placed within the proposed Lease Sale Area. However, by utilizing the National Landcover Dataset (Homer et al., 2015), vegetated areas can be included in the viewshed analysis. As shown in Figure 3.3.6-2, approximately 65% of the 32-km (20-mi) visual study area may have some level of visibility with vegetation included as a screening feature. Of the remaining visible areas, 63% are views from open water; just 2% of the visible area is on land. Therefore, it can be anticipated that the majority of land visibility will occur from the immediate shoreline surrounding Cook Inlet, with some small areas of visibility occurring in the steeper non-vegetated hills and mountains.

Viewers will likely include people partaking in recreation activities, residents, workers, and sightseers and/or tourists to the Cook Inlet area. The visible areas range in distance from 0 to 32 km (0 to 20 mi). The actual visual impacts will vary by viewer distance and position. For example, a foreground view (0 to 4.8 km (0 to 3 mi)) of an operational platform from the water with the Alaska Range as a backdrop would likely result in a noticeable visual impact. However, as the viewer distance increases, the apparent size and thus the perceived visual impacts would likely be reduced (USDOI, BLM, 1986). With this in mind, viewers from the shoreline and beyond will likely experience minimal visual impact from seeing an offshore platform. The majority of residents or visitors in this area will most likely be viewing the platform from greater onshore distances with the exception of recreationists and tourists engaged in on-water activities.

Localized but long lasting visual impacts produced by the lighting of platforms and gas flares can be expected at night. This impact will vary depending on the existing nighttime visual setting and the proximity of the platform to other light sources. Normal operating lights and FAA signals will likely produce light pollution visible from shore and beyond during night with clear skies.

The onshore pipelines associated with oil and gas transport could produce minor to major visual impacts depending on the affected landscape and the desires or expectations of tourists and recreational visitors. The installation and operation of pipelines can require the clearing of vegetation in previously undisturbed landscapes or the interruption of the natural line, form, and color that makes the Kenai Peninsula visually appealing. While the level of impact could vary, pipelines typically have to cross a multitude of land uses, including forested areas, waterfront, and residential areas. However, pipelines generally are installed within existing utility corridors, and they are likely to follow lowlands, which may reduce widespread visibility, thus having localized but long-term visual impacts. Visitors or residents viewing the pipelines from the air may experience widespread visual impacts if they view the entire pipeline or large lengths of it during a single flight tour.

4.3.15.2. Trash and Debris (Including Non-Hazardous Domestic Waste)

Coastal recreational resources would be the resources most vulnerable to adverse effects from routine operations; inland resources would not be affected. One concern is the extent to which discharges of marine debris during routine operations could reach coastal areas important for recreation and tourism. Seeing debris and trash can have long lasting to severe impacts on the aesthetic and scenic values of coastal recreational and tourist areas, particularly shoreline areas.

Offshore operations generate trash that includes paper, plastic, wood, glass, metal, and other materials. The discharge of trash and debris is generally prohibited. All plastic and food debris not passed through a comminutor would be returned to shore for disposal with municipal and solid waste. Consequently, no items larger than 25 mm (1 in.) should be purposefully discharged into the marine environment during routine operations in the proposed Lease Sale Area.

USCG and EPA regulations require operators to proactively avoid accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent the accidental loss of solid waste.

All authorizations for offshore activities would include guidance for trash and debris awareness and management. All vessel operators, employees, and contractors engaged in offshore activities would be briefed on trash and debris awareness and elimination. The objective is to ensure that employees and contractors are aware of the potential effects of and their responsibilities for preventing the discharge of trash and debris into the marine environment, intentionally or accidentally. Finally, operators have developed and implemented practices to improve the handling of and reduce the accidental loss of trash and debris.

Compliance with the various laws, regulations, policies, requirements, and procedures on trash and debris would minimize the potential for adverse effects to recreational, tourism, and visual resources. Routine operations are expected to release few items of marine debris larger than 25 mm (1 in.).

In many cases, trash and debris are more of a perception issue than a direct visual impact. For example, the presence of trash and debris can cause the viewer to perceive a lower visual quality from a location even if the presence of trash and debris does not directly impede or impact the view. The induced perception of reduced visual quality in many ways does immediately impact the user's experience and enjoyment of a particular resource, sometimes for the short-term and other times in the long term. However, the visual impact is likely to be negligible or minor because the presence of trash and debris would likely be localized and incidental rather than widespread and prolonged.

4.3.15.3. Vessel Traffic

Vessels conducting routine operations could cause space-use conflicts with waterborne recreational activities such as recreational marine boating and waterborne wildlife viewing and sightseeing. Space-use conflicts would arise if vessels engaged in routine operations, such as seismic-survey vessels, support vessels, or drilling rigs, cause private or commercial recreational users and tourists to divert from an area to avoid conflicts and no other areas nearby offer similar opportunities.

Overall, the potential for space-use conflicts between vessels that support routine operations and recreational vessels would be limited. Most waterborne recreational and tourist activities in Cook Inlet occur in nearshore areas, especially in or adjacent to national and state parks or other special-use areas such as wildlife refuges. In contrast, on-lease exploratory activities and most routine operations would occur far enough from these areas to avoid space-use conflicts. Facilities would not be sited and operations would not occur where they could obstruct navigable waters or areas of particular recreational value. However, conflicts could occur in the area immediately around facilities during their construction, such as platforms and pipelines. Mostly, these conflicts would be temporary and short-term, ending following construction (the areas surrounding the three platforms would be an exception). Consequently, space-use conflicts between vessels that support routine operations and recreational and touring vessels overall would have minor effects on recreation.

Vessel traffic associated with the Proposed Action will have negligible to minor impacts on visual resources. Cook Inlet has existing commercial and recreational vessel traffic from a visual perspective. Vessel activity in waterfront communities is expected and often seen as a necessary attribute. While an excess of industrial commercial traffic can distract from the existing commercial fishing and recreational boaters, it is not expected to create a visual impact to the surrounding seascape or landscape.

4.3.15.4. Aircraft Traffic and Noise

Excessive air traffic can change one's perception of a landscape, depending on the duration and frequency. The potential for the noise originating from planes and helicopters as they conduct routine operations to affect recreation and tourism or visual resources depends on the amounts and locations of the air traffic. Large amounts of traffic operating near recreational areas could produce sufficient noise to disturb recreationists, but these impacts would be short-term and localized. The potential for such disturbance would be greatest at shoreline recreational areas between Homer and Nikiski because the vessels and helicopters would be transiting between these localities and the platforms.

Overall, the potential for noise from planes and helicopters to noticeably affect recreation and tourism in adverse ways during routine operations is expected to be negligible to minor. The number of trips between the platforms and Homer or Nikiski would be relatively low, 7 to 21 flights per week during exploratory drilling and 21 to 63 flights per week during the production phase. This amount of traffic would not be an increase over aircraft traffic already present in the Cook Inlet region. The onshore support bases are located in the more industrial parts of these localities, which do not immediately adjoin scenic recreational areas. Moreover, the travel lanes between the platforms and onshore support facilities would ensure that vessels and helicopters transit away from shore promptly, which would minimize the exposure of shorelines to noise. Increased aircraft traffic will have a negligible visual impact in the proposed Lease Sale Area. Aircraft will not likely impede or influence the views of recreationists and tourist in the Cook Inlet area.

4.3.15.5. Cuttings Transport and Disposal

Cuttings transport and disposal involves the transport and on shore disposal of drilling fluid and rock cuttings resulting from the drilling process. An existing onshore disposal facility will be used and no construction of new facilities is anticipated. The amount of material is substantial (486 tons of drilling fluids and 839 tons of dry rock cuttings per production well), and substantial space for may be required for disposal. If the waste handling facility or ultimate disposal location is visible to visitors and residents from locations on and offshore, it may produce localized but long lasting visual impacts depending on the location and surrounding landscape uses. These impacts could be perceived or actually experienced at levels ranging from negligible to moderate depending on individuals' desires and expectations.

4.3.15.6. Onshore Support Activities

Onshore or nearshore support services could affect recreation, tourism, or visual resource activities if ongoing support activities at shore bases displaces recreationists or tourist operations. For example, vessels that support routine operations could affect recreational users by displacing them from marine boating facilities and support services for which substitutes are not readily available. In addition, workers that support routine operations could displace recreationists and tourists if they occupy lodging or campgrounds or access to recreational fishing locations. The potential for displacement of and competition with recreationists and tourists is expected to be short-term and localized.

The limited number of vessels would minimize the likelihood of displacing other users from marine-related facilities and services. The helicopters would use existing airports that could easily accommodate the additional 3 to 9 flights per day needed to support routine operations. Although routine operations would have no physical presence on land, local support services would be based in areas of Nikiski and Homer that already support similar oil and gas activities.

Onshore pipeline construction described in Section 4.2.12 is expected to have a short-term and localized effect on visual resources and recreation and tourism visits if the siting of the pipeline occurs in areas used by residents and visitors for outdoor recreation or scenic viewing.

The Proposed Action could directly generate more than 200 new jobs during the height of development and construction, but this number would decrease to approximately 50 long-term jobs during production (Owl Ridge Natural Resource Consultants, 2015). Employment associated with routine operations would not be large enough to induce in-migration of a sufficient number of people to displace recreationists or tourists from lodging, campgrounds, or other facilities.

Routine operations for the Proposed Action are expected to have an overall minor effect on recreation, tourism, and visual resources.

4.3.15.7. Accidental Oil Spills and Gas Release

Non-routine events of primary concern to recreation, tourism, and visual resources are accidental spills of oil or releases of natural gas into the environment. The estimated sizes of accidental spills that could take place during the Proposed Action are discussed in Section 4.2.14 and Appendix A.

Effects of a spill on recreation and tourism would depend on its size, location, and trajectory. Recreational areas that a spill is most likely to affect are those located along the shoreline. Some of the effects of spills on coastal recreational resources might include altering the use of recreational lands or waters and reducing the scenic quality of the recreational experience. Spills could oil the water and shoreline and cause changes to the scenery, behavior of wildlife, or patterns of visitor use, or visitors' experiences in the natural setting.

Small Oil Spills (<1,000 bbl)

Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours, and would be unlikely to affect recreation, tourism, or visual resources. Small spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products. However, even small crude oil spills are not expected to persist on the water long enough to affect waterborne recreational activities or reach recreational areas along the shoreline. The visual impact from a small oil spill could be temporary and localized, and thus minor, and may create some temporary visual distractions.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. In contrast to small spills, a large spill would persist on the water surface longer than a few hours or days, depending on the type of oil spilled. Large spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and would be unlikely to severely affect recreation, tourism, and visual resources. Large spills of crude oil will persist longer in the environment and could result in long lasting and widespread impacts to recreation, tourism, and visual resources.

Oil spill persistence on water or on the shoreline can vary widely depending on the size of the oil spill; the environmental conditions at the time of the spill; the substrate of the shoreline; and, in the case of portions of Cook Inlet, whether the shoreline is eroding. Oil clings to certain types of shoreline, including marshes, peat, fine-grained sediments, and armored cobbled shores, and tends to weather slowly. The oiling of the shorelines of recreational areas and the persistence of oil and spill response and cleanup efforts would moderately and adversely affect recreation, tourism, and visual resources.

Oil that reaches the shorelines of recreational areas would have the greatest potential to adversely affect recreation, tourism, and visual resources. The presence of oil on the shoreline of a recreational area would reduce the attractiveness of that area to recreationists and tourists. As long as oil is present, those portions of the recreational areas would be closed to visitation. After the initial cleanup is completed and the areas reopened, recreationists and tourists would still likely avoid visiting those areas for some extended time due to a perception of contamination. Consequently, oiling of the shorelines of recreational areas from a large spill would reduce the quality of the recreational experience and alter patterns of use of those shorelines. These effects could be long-term and widespread.

A large spill could affect shoreline resources, at which point there would be a moderate visual impact. These impacts would be largely based on the perception of an individual place rather than a direct interruption of visual resources within the entire proposed Lease Sale Area. For example, the perception of people visiting a coastal park or beach that was directly affected by an oil spill may visually impact that beach. However, the visual elements that make that beach a scenic place may include the water, trees, and backdrop of 6,100-m (20,000-ft) high mountains. Those resources would not necessarily be visually affected, but the overall perception could be, thereby impacting their scenic value to a visitor or resident. This is due to the expectation that certain landscapes should be pristine.

BOEM estimates that a well control incident of a single well could occur under the Proposed Action that results in the release of 8 MMcf of natural gas in one day. An accidental release of natural gas into the environment is unlikely to affect recreation, tourism, or visual resources. Released gas would be expected to rise and disperse, and have no impacts on recreation, tourism, or visual resources. A large gas release that resulted in an explosion and fire could have temporary and localized degradation of visual resources in the proposed Lease Sale Area.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

BOEM's OSRA model estimates a large spill would likely contact the shoreline of at least some recreational areas adjacent to the proposed Lease Sale Area. The conditional probabilities of a large spill contacting the shoreline vary with the specific resource location and source of the spill (LA or PL). The OSRA model estimates a 19% to 22% chance of a large spill contacting AMNWR–W Cook Inlet (GLS 127) or Lake Clark National Park and Preserve (GLS 128) within 1 day, 49% to 55% within 10 days, and 49% to 58% within 30 days, assuming a spill ≥1,000 bbl occurs at LA1. Within 30 days, assuming a large spill occurs, oil from most of the LAs or PLs would have a 20% to 60% chance of reaching the shorelines of these two important recreational tourism areas (except LA5, LA6, and PL3).

OSRA conditional probabilities suggest that Katmai National Park, Kenai National Wildlife Refuge (GLS 123), Kenai Alaska State Recreation Management Areas (GLS 135), and Kodiak National Wildlife Refuge (GLS 156) would be the areas with the highest chance of a large spill contacting their shorelines from any LA or PL. For these GLSs, the annual chance of a large spill contacting shore ranges from approximately 2% to 18%, depending on the LA or PL, within 30 days. The chance of a large spill contacting the other recreational areas in the proposed Lease Sale Area is generally <10%. Consequently, although the shorelines of all recreational areas adjacent to the proposed Lease Sale Area could have a chance of a large spill contacting, the areas identified previously are the most likely to have oil contact their shorelines. Combined probabilities (the percent chance of one or more large spills occurring and contacting any portion of a particular resource) are 6% to 11% for GLS 127 and 5% to 7% for GLS 128 within 3 and 30 days, respectively. All other combined probabilities for parks are ≤2%.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread.

The effects of response and cleanup for a large oil spill on recreation and tourism activities and resources would depend on a variety of factors, including location of the spill, time of year, size of the spill, and weather conditions. Waterborne recreational activities such as recreational marine boating and waterborne wildlife viewing and sightseeing would be directly affected as the area involved in the spill is closed to facilitate the spill response. Waterborne activities in portions of the proposed Lease Sale Area that adjoin the spill area would be indirectly affected by the noise, increased level of activity, and numbers of vessels, which would reduce the quality of the recreational experience. These effects would last at least as long as the spill response and cleanup is ongoing.

Cleanup operations may create some temporary and localized visual distractions and thus would cause minor impacts to visual resources.

4.3.15.8. Impact Conclusions

The effects of the Proposed Action on recreation and tourism would primarily arise from space-use conflicts. However, these activities usually take place in different locations or at different times; when they coincide, the duration would be short-term and localized. Minor to moderate visual impacts produced by the lighting of offshore platforms and gas flaring can be expected at night. This impact will vary depending on the existing nighttime visual setting and the proximity of the platform to other light sources. The onshore pipelines associated with oil and gas transport could produce minor to moderate visual impacts depending on the affected landscape. Excessive industrial commercial traffic can impact recreational boaters and would likely have **negligible** to minor visual impacts on the surrounding seascape or landscape. Overall, the effects of routine activities on recreation, tourism, and visual resources are expected to be **minor**.

Potential small spills of diesel fuel, crude oil, and condensate are not expected to affect recreation or tourism in the proposed Lease Sale Area. Small spills would be dealt with using routine spill prevention and response measures. Most small spills would be contained on a vessel or platform. In addition, spills of refined fuel that reach the water would evaporate and disperse in hours to days. Consequently, small spills are not expected to persist on the water long enough to affect waterborne recreational activities or reach recreational areas along the shoreline. It is unlikely that a small spill would have more than a minor visual impact as it is likely that the spill would evaporate or dissipate before reaching coastal resources. Small spills would result in little or no impact and thus have **negligible** effects on recreation and tourism. Small spills are expected to have **minor** impacts on visual resources due to their short-term and localized effects.

An accidental large oil spill could cause long lasting and widespread effects to coastal-dependent and coastal-enhanced recreational and tourism values, especially where oil makes contact with the shoreline. The effects would last the duration of the spill response and cleanup activities. Overall, potential effects of a large spill on recreation, tourism, and visual resources are expected to be **moderate**. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for recreation, tourism, and visual resources for accidental spills. Also, GUIE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for recreation, tourism, and visual resources with regard to routine activities.

4.3.16. Sport Fishing

As indicated in Section 4.2, the following IPFs may affect sport fishing: (1) noise, (2) vessel traffic, and (3) accidental oil spills and gas releases.

The Proposed Action could have minor and beneficial effects on the Cook Inlet sport fishing industry. As discussed in Section 4.3.10, the Proposed Action could result in an increase in local residents in the surrounding environs for a number of years, prompting local charters and other tourism-related businesses to realize a short-term and localized increase in business, angler days, equipment sales, and other income such as hotel and lodge rentals or hiring of commercial sport fishing guides. The state could receive increased revenue from license fees.

4.3.16.1. Noise

Active Acoustic Sound Sources

Routine operations associated with the Proposed Action are expected to have minor effects on fish and shellfish import to the sport fishery (Section 4.3.5.9).

Active acoustic sound sources typically require the establishment of a stand-off safety exclusion zone. Notification of activity and establishment of such a zone will be announced to the public and marine users through issuance of a Local Notice to Mariners. Given the small areas in question and the fact that sport fishing is a very elastic industry, the impacts from safety exclusion zones due to displacement of sport fishers is expected to be negligible.

Little or no significant direct effects to the razor clam sport fishery would be expected from active acoustic sound sources during the exploration phase of the Proposed Action. Acoustic noise from seismic exploration, for example, is not expected to extend to the shallow tidal nearshore areas where razor clams are harvested by sport fishers.

Indirect effects to razor clam sport fisheries could occur from active acoustic sound sources, specifically seismic surveys. As part of their lifecycle, razor clams have a planktonic larval stage similar to scallops. Aguilar de Soto et al. (2013) found exposure of scallop larvae to playbacks of seismic pulses of 160 dB_{rms} re 1 μPa caused developmental delays and body abnormalities. Aguilar de Soto et al. (2013) noted the possibility of reduced recruitment, and as such, a delayed impact on stocks of mature individuals, potentially affecting the availability of future razor clam sport fisheries. Planktonic larvae are unable to escape exposure to airgun noise associated with seismic surveys. However, the potential for impact is low given airguns would need to pass within meters of the clam larvae to have any detrimental effects. Although it is likely that some larvae will be exposed to detrimental sound levels, the small fraction of the proposed Lease Sale Area covered by seismic surveys and the widespread nature of clams in Cook Inlet make a population-level impact highly unlikely. Impacts to clam larvae would be short-term and highly localized and thus minor. Effects to the overall clam fishery from noise associated with the Proposed Action are expected to be negligible. Section 4.3.5.5 described the effects of noise from routine operations on fish and shellfish.

Drilling and Equipment Noise

Much of the noise associated with drilling and equipment use would only increase to 20 to 40 dB above background levels (see Section 4.2.5.2). Some activities such as those caused by drillships during drilling and the use of thrusters could range from 154 and 188 dB re 1 μPa @ 1 m (see Section 4.2.5.2). BOEM anticipates that noise transmitted from fixed platforms would be weak due to the elevation of the structure and the lack of contact with the water column (USDOI, BOEM, 2012b). The nature of drilling and equipment noise would be vibrational, tonal, and at low frequencies, as opposed to acoustic noise and airgun uses, which would be more sporadic and acute. It is anticipated that any direct effects from this noise to sport fisheries would attenuate within the imposed stand-off distances and be considered negligible.

No direct or indirect effects to the razor clam sport fishery would be expected from drilling or equipment noise. It is not expected that noise from these activities would carry into the intertidal areas of Cook Inlet where recreational razor clam harvesting is most popular.

4.3.16.2. Vessel Traffic

Increased vessel traffic as a result of implementing the Proposed Action could have short-term and localized, and thus minor direct and indirect effects on sport fishing during all phases of the Proposed Action.

The primary effect to sport fisheries would be from temporary displacement of fishing boats and charters from sport fishing grounds during exploration and drilling activities. During exploration drilling, operations would be supported by supply vessels. Support vessel traffic is estimated to consist of one to two trips per MODU per week from Homer or Nikiski. Seismic and geotechnical surveys would likely require temporary restricted access to specific areas in Cook Inlet for sport fishers. For safety reasons, survey operators will maintain a stand-off safety exclusion zone around the source vessel if it is towing a streamer array; establishment of this zone will result in a temporary and minor space-use conflict with other vessels, including sport fishing boats. The size of the stand-off distance varies depending on the array configuration; however, a typical stand-off distance would be approximately 8.5 km (4.6 nmi) long and 1.2 km (0.6 nmi) wide. The length of time that any particular point would be within the stand-off distance would be approximately 1 hour. The USCG would issue a Local Notice to Mariners, which would specify the survey dates and locations and the recommended avoidance requirements for other vessel traffic, including sport fishing vessels.

The OCS construction (i.e., platform and pipeline installation), development drilling operations, and normal production operations would be supported by supply vessels from existing facilities located in Homer or Nikiski. Support-vessel traffic is estimated to consist of one to two trips per platform per week from Homer or Nikiski. Long-term stand-off distances may be established for drilling rigs, platforms, and supply vessel routes to ensure safety. A typical stand-off safety exclusion zone is a 500-m (1,640-ft) radius around all vessels and equipment from which all other vessels, including fishing, commercial, and recreational, would be excluded. Therefore, localized impacts may be associated with the Proposed Action if it is in close proximity to or is restricting access to favored fishing grounds. However, sport fishing is an elastic industry, which allows it to adopt surrogate fishing grounds should one area have restricted access. The severity of the impact on the resource depends on whether it would be feasible for a charter company to revise their tours, whether the physical presence of the oil exploration/production infrastructure deters from the perceived value of the activity, and if this would result in reduced bookings due to perceived decreased value by potential sport fishers.

4.3.16.3. Accidental Oil Spills and Gas Release

Non-routine events, specifically accidental large oil spills (≥1,000 bbl) resulting from the Proposed Action, could affect sport fishing. Impacts would likely be limited to work occurring during summer months, which is the primary sport fishing season in Cook Inlet. Impacts to sport fishing as a result of accidental spills could extend beyond the summer recreational fishing season, depending on the size of the oil spill involved. These impacts are generally negative, but are short-term and minor.

Small accidental discharges of oil can occur during almost any stage of exploration, development, production, or decommissioning on the OCS or in nearshore coastal areas. The CWA and the Oil Pollution Act include regulatory and liability provisions that are designed to reduce damage to natural resources from oil spills. Therefore, small oil spills (<1,000 bbl) are treated as an accidental IPF and are dealt with using routine spill prevention and response measures. As detailed in Section 4.2.14, the two general spill size categories considered in the oil spill analysis are small spills (<1,000 bbl) and a large spill (≥1,000 bbl).

Small Oil Spills (<1,000 bbl)

Section 4.2.14.2 provides a detailed discussion on the small spills of crude oil and condensate estimated from all phases of the Proposed Action. Overall, adverse effects on sport fishing from small accidental spills would likely be short-term and localized, and thus minor. Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours, and would be unlikely to have long lasting or widespread effects on sport fishing. Small spills of crude oil could persist longer in the environment and could result in greater impacts than spills of refined products but are also expected to be short-term and localized.

These spills would predominantly occur within the confines of the offshore facility and its stand-off safety zone. Furthermore, these small spills are anticipated to be contained with the on-site spill response resources, further minimizing the geographic extent of any impact. Therefore, for isolated small crude oil and condensate spills, minor impacts are expected to sport fishing resources.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large spill of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and could temporarily affect sport fishing due to area closures in the localized area of a spill. A large spill of crude oil would persist longer in the environment and could result in impacts to sport fishers.

The OSRA model estimates some percent chance of a large spill contacting LSs along the western side of the Kenai Peninsula, which would limit the ability of sport halibut and salmon fishers from setting out from oiled locations. Many of the charter operators use tractors to launch their boats from the shallow beaches. The sport fishers could use alternate locations, but some of the charter operators could lose business (Herrmann, Todd, and Hamel, 2001).

BOEM estimates that a well control incident of a single well could occur under the Proposed Action that results in the release of 8 MMcf of natural gas in one day. A single day release of 8 MMcf of gas would not be expected to have long lasting and widespread impacts on sport fishing but could temporarily exclude sport fishers from the immediate area of the blowout.

Effects on Charter Boat Operators and Other Salmon and Halibut Fishers

In the absence of recent large oil spills in the area, this analysis relies on the impacts assessments from the 1987 *Glacier Bay* oil spill in Cook Inlet, among other data. The impact conclusion regarding sport fishers for halibut and salmon is based on the growth of the charter businesses north of Homer along the west side of the Kenai Peninsula. These charter operations often use tractors to launch their boats from shore, rather than from a more protected port. Oil on the beach would restrict this method of boat launching. If the charter operations were based only out of harbors such as Homer Spit, Ninilchik Creek, or Kenai River, the conclusions would be different. In 1987, at the time of the *Glacier Bay* oil spill, nearly all sport halibut and salmon charter boats used the port in Homer. A report on the July 2, 1987, stated that the oil spill had “no measurable impacts” on sport fishing (Northern Economics, 1990). The *Glacier Bay* was in transit from Valdez to the Kenai pipeline facilities when it is assumed to have hit an uncharted rock approximately 32 km (20 mi) west of the Kasilof River. The ADEC estimated that the *Glacier Bay* spilled 3,100 bbl of oil, based on calculations of oil unaccounted for when, on July 5, 1987, it completed unloading oil at the Kenai pipeline facilities (Northern Economics, 1990). For purposes of analysis, a spill of 3,100 bbl of oil is assumed to be within the range of 5,100 bbl of oil; therefore, the effects of the *Glacier Bay* oil spill would approximate the effects of a spill as much as 5,100 bbl.

The waters of Cook Inlet and Kachemak Bay and the rivers and streams flowing into Cook Inlet account for a large proportion of the total sport fishing effort for the entire state. At the time the *Glacier Bay* oil spill occurred, several popular sport fishing seasons had completed. The early runs of Kenai River chinook (king) salmon, Russian River sockeye (red) salmon, Kasilof River chinook (king) salmon, and lower Kenai Peninsula (i.e., Deep Creek, Ninilchik Creek, Anchor River, Homer Spit, and Halibut Lagoon) chinook salmon were over. However, on July 2, the most popular sport fishing seasons were just beginning. The halibut charter boat fishery receives the largest number of clients during July and August. The second-run Kenai salmon fishery was just beginning with constant activity through the month of July. The silver salmon fisheries on all rivers and streams on the Kenai Peninsula do not begin until the latter part of July and run through September and even later. Northern Economics (1990) did not find evidence of losses in these sport fisheries due to oil-fouled boats or gear, loss of fishing opportunity, or harvest of oil-fouled fish that had to be discarded (with one exception). Also, none of the fishing groups that Northern Economics contacted had legal claims for damages resulting from the *Glacier Bay* oil spill. When Northern Economics began its study of the *Glacier Bay* oil spill, it was anticipated that the spill would affect the halibut fishery in Cook Inlet the most. However, the 1987 president of the Homer Alaska Charter Association indicated that the spill did not impact the halibut charter boat fleet operating out of Homer.

An oil spill could result in closure of ports in Homer, Kenai, and elsewhere along the west side of the Kenai Peninsula. Ports probably would be closed to protect the port and vessels from being oiled. Oil spills can cause economic losses to boat owners and fishers by contaminating fishing gear and vessels. Oiled vessels would need to be cleaned, and oiled gear cleaned or replaced. It is anticipated that fishers would fish alternate areas because of port closures. Charter operators would avoid going out of port into Cook Inlet to avoid fouling their gear and vessels. Public perception of oil spill damage, real or perceived, would diminish the number of sport fishers. Sport fishers likely would target alternate fishing grounds until the quality of the fishing experience, real or perceived, in the oil spill area returned to previous conditions. These effects could last for one or more fishing seasons and be widespread depending on the size and timing of the large oil spill.

Effects on Clam Gatherers

Oil contacting the beaches could affect clam gathering. People gather razor clams and other clams for sport along the east and west sides of Cook Inlet, and mussels and steamer clams in small bays in Kachemak Bay. For effects on these species, see Section 4.3.4. As described in Section 4.3.9, populations of intertidal organisms in any area contacted by oil would be depressed measurably for about a year, and small amounts of oil would persist in the shoreline sediments for more than a decade. The difference in effect between large and small spills is in the extent of areal coverage of impacted shoreline. While small spills would not be expected to impact the nearshore environment, large spills may have a long-term and widespread impact on clam gathering. The OSRA assumes a large oil spill would be ≥1,000 bbl. There is a chance that the oil could migrate to the coastline and nearshore environments resulting in long-term closure of these areas and thus adversely affecting clam gathering.

Sport fisheries are an important part of recreation and tourism. For more information on the effects on recreation and tourism, see Section 4.3.15.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

The summary results for anadromous fish provided in Table 4.3.2-7 are used as a proxy for percent chance of contact to sport fishing resources as sport fishing and anadromous fish rely on access to the nearshore environment/coast. Anadromous fish in Cook Inlet and the surrounding region are represented in the OSRA model by LSs and GLSs listed in Table A.1-12 of Appendix A.

Oil spills could contact LSs on the western side of Cook Inlet (LSs 18 to 36) and Kalgin Island (LS 38). The LSs along the western shore of the Kenai Peninsula where a large number of small shore-based charter boats are based (LSs 54 to 58 and 60 to 63) could be affected during the summer months (Table 4.3.2-7). The highest combined probabilities within 30 days range from 1% to 3% for the west side of Cook Inlet (LS 30 to 36) to <0.5% to 1% for the east side of Cook Inlet (LS 61 and 62). Oil contact with the shore and nearshore environment could restrict small shore-based charter boats and private sport fishing boats from being able to launch their craft in these areas. However, since most of these sport fishing boats are trailer launched, they are mobile and are assumed to be able to avoid much of the oil resulting from a large oil spill. As shown in Appendix A, Table A.2-29, for many LSs, the probabilities of an oil spill will contact a certain LS within 30 days in the summer range in the single digits for the west side of the Kenai Peninsula, to as high as 15% for Chinitna Bay on the east side of Cook Inlet. Widespread and long lasting effects on the sport fishing industry could result from a large oil spill and moderate impacts are expected.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations.

Pelagic fishes important for sport fishing may be affected by mechanical recovery of spilled material, but are expected to avoid an oiled area and to move away from vessels and booms or skimmers. If spill response activities are occurring during salmon spawning runs, some fish could experience difficulty reaching their spawning grounds. These avoidance impacts of pelagic fishes would be short-term and localized to the spill area and thus minor. Benthic fishes and shellfish would not likely be affected by mechanical spill recovery activities occurring at the surface. The effects of mechanical recovery on benthic fish and shellfish resources used by sport fishers would be negligible.

In-situ burning of spilled oil is used to remove oil from the surface and would impact fish and shellfish in the immediate area due to increased water temperature and residue from the burn sinking to the bottom. Death of pelagic fishes that did not move away from the spill is possible in the immediate burn area. Residue from a burn can sink and smother benthic fish and shellfish. These effects are expected to be short-term and localized to the immediate burn area, and would be considered minor.

The use of dispersants could result in impacts on plankton communities. Ramachandran et al. (2004) suggested that the use of oil dispersants will increase the exposure of fish eggs and larvae to hydrocarbons in crude oil. This has particular importance if dispersants are used while outmigrating salmon are present in the area. Dispersed oil could have toxic effects to benthic fish and shellfish communities used in the sport fishery.

These effects could be long-lasting and widespread for sport harvested fish and shellfish if a large spill occurs. Effects are unlikely to be population-level, though, as fish can avoid areas of spilled oil, and benthic community impact on shellfish would be limited spatially by the settling of oil and dispersant. Depending on the size of the spill and the time of year, use of dispersants could have minor (small spill) to moderate (large spill) effects on fish and shellfish used in the sport fishery.

Increased vessel traffic would add noise to the environment, and would increase the chance of small discharges from response vessels. Effects of vessels used in spill response and cleanup to fish and shellfish are not expected to occur and would have a negligible impact on the sport fishery.

Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread. Overall impacts of spill response and cleanup activities on sport fisheries in Cook Inlet could range from minor to moderate.

4.3.16.4. Impact Conclusions

The effects of routine activities on sport fishing would be geographically limited and short-term. Activities that would occur under exploration, development, production, and decommissioning could temporarily limit access to some regular sport fishing areas and may displace some populations of sport species such as salmon and halibut in the short term. It is likely that charters and individual sport fishers would be able to use alternative fishing grounds; therefore, charters would not likely lose a large portion of business as a result of routine operations. The overall effects of routine activities during the Proposed Action on the sport fishing community and industry would be **minor**.

The effects of small spills would be considered **minor** because they are anticipated to be contained with the on-site spill response resources, which will minimize the geographic extent of any impact.

However, a large oil spill could cause long lasting and widespread effects to the sport fishing community and industry. An accidental oil spill could contact LSs along the western side of the Kenai Peninsula, which would limit the ability of sport halibut and salmon fishers from setting out from oiled locations. The fishers could use alternate locations, but some charter operators may lose business. These effects could last for one or more fishing seasons.

Oil contacting the beaches could affect clam gathering, particularly for razor clams and other types of clams along the east and west side of Cook Inlet, and mussels and steamer clams in small bays in Kachemak Bay. In any area contacted by oil, populations of the intertidal organisms could be depressed measurably for about a year, and small amounts of oil likely would persist in the shoreline sediments for more than a decade. The overall effects of a large spill would result in **moderate** impacts on sport fishing resources. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for sport fishing for routine activities or accidental spills. Also, GUIE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for sport fishing with regard to routine activities.

4.3.17. Archaeological and Historic Resources

The following IPFs could affect offshore and onshore archaeological and historic resources: (1) seafloor or ground disturbance and habitat alteration; (2) drilling discharges; (3) physical presence, including lights; and (4) accidental oil spills and gas releases.

The depth distribution of submerged cultural resources is an important consideration when evaluating the potential for impact. While historic shipwrecks may occur at any water depth, prehistoric resources are depth-limited. The highest probabilities for encountering submerged prehistoric sites in the Cook Inlet region are on relic landforms at depths between 0 to 60 m (0 to 197 ft).

4.3.17.1. Seafloor or Ground Disturbance and Habitat Alteration

Routine activities associated with the Proposed Action that have been identified in association with seafloor disturbance include node placement (3D surveys), anchor placement (MODUs and pipelines), drilling (MODUs and caisson platforms), trenching (pipelines), and seafloor sampling.

The National Historic Preservation Act (NHPA), specifically Sec. 106, requires that archaeological surveys precede proposed actions that have the potential to affect historic properties. Thus, prior to seafloor disturbances, there would be a need to perform an archaeological survey sufficient to identify the presence of any seafloor or sub-seafloor historic property, or historic property on land, as archaeological surveys would also be required of terrestrial pipelines linking the sea bed pipeline to an appropriate facility. The surveys would engage the State Historic Preservation Officer (SHPO) in a review process. BOEM would document a finding of effect on historic properties, including a finding of no historic properties affected within the area of potential direct or indirect effect. There is always the possibility of a discovery being made during the ground disturbing activity. These potential impacts are discussed in the following paragraphs.

The placement of equipment (e.g., anchors, cables, nodes) on the seafloor has the potential to damage any archaeological resources present. BOEM assumes that two marine seismic surveys could be conducted during the first two years of the E&D Scenario. These are expected to be 3D surveys as described in Section 2.4. Marine seismic surveys typically are conducted prior to geohazard surveys, and those employing bottom-founded equipment could directly impact an unrecorded shipwreck or prehistoric site. The extent of the impact should be local and occur only where an OBN or OBC comes into direct contact with the seafloor. The intensity of the impact may vary depending on whether an OBN/OBC comes into direct contact with an archaeological resource and the extent of the damage which might occur.

Seafloor-sampling activities from geotechnical surveys could affect shipwrecks and prehistoric archaeological resources via physical damage. Sampling may include gravity/piston corers, grab sampling, or dredge sampling. Shallow coring may be employed using a conventional rotary drill. Four to five geotechnical surveys are expected during the exploration phase of the E&D Scenario. The extent of the impact would be local and occur only where sampling equipment comes into direct contact with the seafloor. The intensity of the impact may vary depending on whether a sampler comes into direct contact with an archaeological resource and the extent of the damage which might occur.

Additional seafloor or ground disturbances may result from well drilling and the placement/anchoring of structures (e.g., pipelines, MODUs, caisson platforms) on the seafloor, or, with regard to pipelines, on land. See Section 4.2.1 for a complete description of proposed seafloor-disturbing activities that are estimated to occur under the Proposed Action. Impacts to archaeological resources from wells and structure placement disturbances are expected to be local in nature and occur where an activity directly disturbs the seafloor. The intensity and duration of an impact can vary depending on whether an activity comes into direct contact with a resource. Should the activity come into direct contact with a shipwreck, it could physically damage the hull structure, resulting in the loss of archaeological data on ship construction, or it could damage or disturb artifacts, resulting in the loss of social information of the crew and cargo. Impacts to historic aircraft would be analogous to shipwreck disturbances. Impacts to buried prehistoric sites may include destruction of artifacts and site features as well as disturbance of the stratigraphic context of the site. While the intensity of the damage may vary according to degree of impact, the duration of the impact is long-term as archaeological resources are unique nonrenewable resources.

Indirect seafloor disturbances can further impact an archaeological site by altering the dynamics of the seafloor and the water currents in the vicinity of a shipwreck or prehistoric site. While not directly impacting the resource, the placement of wells, platforms, or pipelines nearby can cause the surrounding seafloor to slump or may change the direction and intensity of local currents scouring or exposing cultural resources and upsetting the equilibrium that the resource previously had with the environment, causing deterioration or eventual loss of the resource and the information it contains. The extents of such impacts are expected to be local. The intensity would vary depending on the degree to which the activity alters the local environment.

Any offshore pipeline that required an onshore component would also be subject to an archaeological survey and Sec. 106 consultation of the area of potential effect, as would a barrow pit if materials were necessary for infrastructure on- or offshore.

4.3.17.2. Drilling Discharges

Drilling waste discharges include drilling fluids and cuttings. The potential impact to archaeological and historic resources depends on the activity and whether a resource is present within the area of potential effect for that activity. The discharge of drilling fluids and cuttings may impact an exposed shipwreck or prehistoric site through burial. Because Cook Inlet is a high-energy environment, any discharges are expected to be quickly transported away by strong currents (Hannah and Drozdowski, 2005). The extent of the impact would depend on the proximity of drilling discharge locations to a shipwreck or other archaeological resource. Should an impact occur, the intensity of the impact is expected to be low to medium, depending on how quickly the discharges disperse before reaching the seafloor.

4.3.17.3. Physical Presence, Including Lights

Depending on the location of potential activities, there may be visual impacts to onshore historic properties. The OCS boundary is located 5 km (3 nmi) from the coastline, and no OCS block is located more than 38 km (24 mi) from the nearest shoreline. Based on the existing level of vessel activity and ongoing oil and gas exploration and development in state waters, it is not expected that additional physical presence of offshore structures from the Proposed Action would cause further impacts to onshore historic properties or to Alaska Native communities.

4.3.17.4. Accidental Oil Spills and Gas Release

Accidental spills could affect archaeological resources during all phases of the E&D Scenario, depending on the spill type, source, and spill size.

Small Oil Spills (<1,000 bbl)

Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and would not be expected to impact seafloor archaeological resources. Small spills of crude oil will persist longer in the environment and could adhere to PM in the water column, sink, and impact a shipwreck site or exposed prehistoric site on the seafloor. However, due to the high-energy environment of Cook Inlet, it is expected that the portion that had not dispersed would be quickly transported away by strong currents (Hannah and Drozdowski, 2005). The intensity of the impact from a small spill should be negligible as it is expected to disperse and volatize or be cleaned quickly. The components that may reach the shoreline or the seafloor are expected to be in low concentrations and should also result in a negligible effect.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. Like small spills, a large oil spill may occur during all phases of the E&D Scenario; however, such spills are more likely to occur during development and production with wells, pipelines, and platforms being the most common sources.

A large spill of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and would be unlikely to affect seafloor archaeological resources. A large spill of crude oil will persist longer in the environment and could adhere to PM in the water column, sink, and impact a shipwreck site or an exposed prehistoric site on the seafloor.

Submerged shipwreck or historic aircraft sites can be affected by contact with oil. Exposed material such as elements of the hull, cargo, and other associated debris usually are colonized by corals and other organisms. Once a wreck site is covered by these organisms, it typically achieves a state of equilibrium and is protected from further deterioration. Oil from a spill can destabilize the environment, causing a die-off of the biota protecting the site and increasing the potential for renewed degradation. Terrestrial studies by Ejechi (2003) on wood in oil-contaminated soils in Nigeria showed that while the oil initially had a positive effect in retarding deterioration, the long-term effects of contamination indicated an increase in deterioration. As part of the *Deepwater Horizon* response, BOEM is sponsoring a study examining how oil, dispersed oil, and chemical dispersants used during the cleanup effort have interacted with and become incorporated with select wooden and steel hulled shipwreck sites, the surrounding seafloor, and the resident biota (MBAC, 2015). Impacts from such events are expected to be local, affecting the immediate wreck area. While studies are underway to determine the intensity and duration of the impacts of a spill, preliminary indications are that the intensity of the impact is high in that the oil will be visible and is known to cause deleterious impacts to benthic communities that inhabit wreck sites (White et al., 2012).

Coastal and intertidal archaeological sites could be affected by contact with oil from a large spill. As described by Exxon Valdez Oil Spill investigations (Dekin et al., 1993; Wooley and Haggarty, 2013) and reiterated in previous EIS documents (e.g., the Liberty Development and Production Plan Final EIS (USDOI, MMS, 2002)), the greatest effects to onshore archaeological sites in an oil spill were not from the oil itself but from subsequent cleanup activities. Cleanup activities could impact beached shipwrecks, 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 potential for archaeological sites to be recognized, resulting in the site having a higher chance of being vandalized. Unauthorized collecting of artifacts by cleanup crew members also is a concern, albeit one that can be mitigated with effective training and supervision. Effects to archaeological resources during the Exxon Valdez Oil Spill were due to physical disturbance from cleanup equipment and to vandalism by cleanup workers. Regardless, researchers concluded that <3% of the archaeological resources within the spill area suffered any significant effects.

BOEM estimates that a well control incident of a single well could occur under the Proposed Action, resulting in the release of 8 MMcf of natural gas in one day. A release may occur from a loss of well control, a ruptured or leaking pipeline, or from onshore facilities. It is assumed that in year 8, when natural gas production commences, there could be one well control incident from any single well on a platform. Because any released gas would dissipate rapidly, no impacts on submerged or coastal archaeological resources is expected. A large gas release that resulted in an explosion and fire could adversely impact any submerged archaeological resource in the vicinity of the blowout. Pre-drilling geohazard surveys should preclude the possibility of archaeological resources within the vicinity of the wellsites, and any impacts of a gas blowout and resulting explosion or file are considered negligible.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Archaeological resources such as historic shipwrecks, aircraft, and artifacts may be found anywhere within the proposed Lease Sale Area. Submerged shipwrecks, aircraft, and prehistoric sites located in the proposed Lease Sale Area and those located in the vicinity of the hypothetical LAs (Appendix A, Map-A-5) are at most risk of being impacted. Archaeological sites in ERAs beyond the extents of the LAs are expected to be little impacted during a spill event.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread.

4.3.17.5. Impact Conclusions

BOEM will review site-specific information regarding potential archaeological resources in Alaska waters prior to approving any lease-related activities involving seafloor disturbance, including placement of bottom-founded equipment or structures. In accordance with Sec. 106, BOEM will correspond with the SHPO when the Federal official makes any finding regarding historic properties, including “no historic properties will be affected” and will furnish the SHPO with copies of archaeological reports. If a a pre-disturbance survey finds evidence of a possible archaeological resource in a lease area, the lessee must move the proposed activity so as to avoid the possible resource or conduct further investigations to determine whether an archaeological resource actually exists. Should a historic property be located that cannot be avoided, BOEM will consult with the SHPO and the public, including Alaska Native tribes (as defined by the NHPA) concerning mitigating measures. While archaeological and historic resources are nonrenewable resources and any routine activity could have a potential long-term negative impact, the likelihood of direct impacts to archaeological and historic resources is expected to be low due to required geohazard and archaeological surveys prior to ground disturbing activities. As a result of the earlier analysis, the impacts of routine operations in Cook Inlet from the Proposed Action on archaeological and historic resources are expected to be **negligible**.

In the case of accidental spills, some impacts on shoreline archaeological and historic sites, historic shipwrecks, and submerged prehistoric archaeological resources may occur. The degree and severity of the impacts would depend on the size of the event; the larger a spill, the greater the likelihood that sensitive archaeological resources could be impacted. Cook Inlet is a fairly narrow body of water.

Spill events have a chance of reaching shore and impacting archaeological and historic resources. While strong currents would disperse much of the oil lost during a spill, some could reach the seafloor and come into contact with a historic shipwreck or submerged prehistoric site. Historic shipwrecks are invaluable cultural resources and may also serve as artificial reefs, enhancing marine biodiversity. Oil and gas-related activities have the potential to impact shipwreck sites. An estimated 30% of the oil from the *Deepwater Horizon* spill was deposited in the deep-sea, in areas that contain shipwrecks. Field and laboratory experiments were conducted to determine if crude oil, dispersed oil, and/or dispersants affected the community composition, metabolic function, and/or corrosion potential of microorganisms inhabiting shipwrecks. Oil- and oil/dispersant-treated metal proxies for shipwrecks exhibited higher corrosion compared to dispersant and control treatments. These findings indicate that exposure to oil and/or dispersant may alter bacterial community composition and corrosion potential of wooden and steel hulled shipwrecks and their debris fields (Procopiou, 2016; Sumner, 2016).

Damage could also include contamination and, deterioration of the resource as well as indirect effects from vandalism or physical disturbance from cleanup activities. While following proper procedures and cleanup protocols developed during the *Exxon Valdez* and *Deepwater Horizon* oil spill events would mitigate most impacts, some impacts may still result in the loss of information. As a result, the impacts of accidental spills from the Proposed Action on archaeological and historic resources would be **minor** for small spills and **moderate** for large spills, based on the severity of the spill and the proximity of archaeological resources. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for archaeological and historic resources for routine activities or accidental spills. Also, GIUE (e.g., oil spill drills), which are infrequent, of short duration, (<8 hours), localized and utilize existing equipment, would not alter impact conclusions for archaeological and historic resources.

4.3.18. Areas of Special Concern

As discussed in Section 4.2, through preliminary screening of the activities and affected resources, IPFs for the Proposed Action with potential impacts on Areas of Special Concern are (1) other operational discharges; (2) air pollutant and greenhouse gas emissions; (3) physical presence, including lights; (4) aircraft traffic and noise; and (5) accidental oil spills and gas releases (Table 4.2-1).

4.3.18.1. Other Operational Discharges

Other operational discharges as part of routine operations include sanitary wastes, gray water, cooling water, and other miscellaneous discharges (e.g., bilge, ballast, and fire water; deck drainage). Sources of these discharges are vessels (support, service/construction, seismic, and drilling) and platforms, and these discharges will occur in all phases of the E&D Scenario in the Proposed Action. The types of discharges and regulations are discussed in Section 4.2.3. While the Proposed Action will not occur within 4.8 km (3 mi) of the coastline, vessels will be required to travel to and from port facilities and pass through coastal waters adjacent to Areas of Special Concern (Figure 3.4.3-1).

Discharges would occur during normal operations and in small volumes, and would produce localized and temporary effects on water quality. However, the discharges are expected to dilute and disperse rapidly through mixing by currents and regular tidal flushing in Cook Inlet. If discharges occur within confined portions of some channels, the volume or flow of water may be insufficient to adequately dilute and mix the discharges, and result in degraded water quality. Compliance with applicable state-issued or Federal NPDES permits and USCG regulations would prevent or minimize minor impacts to water quality.

The Proposed Action would contribute to the use of existing onshore facilities located throughout the Cook Inlet Planning Area. These supporting onshore facilities would discharge into local wastewater treatment plants and waterways during routine operations and could impact coastal water quality; the types of onshore facilities are discussed in Section 2.4.5. Routine operational discharges from existing onshore facilities associated with the Proposed Action are expected to be negligible for Areas of Special Concern.

The activities that will occur under the Proposed Action will result in discharges from platforms, drilling vessels, and supply and service/construction vessels as part of normal operations and could contribute to localized degradation of water quality. However, on platforms and drilling vessels, sanitary and domestic waste would be routinely processed through on-site USCG-approved MSDs before being discharged overboard. Similarly, deck drainage and bilge, ballast, and fire water would be treated on site to remove oil and other contaminants prior to discharge per USCG and EPA General Permit AKG-31-5000 for oil and gas exploration facilities in Cook Inlet. Discharges from development and production facilities are authorized under the EPA General Permit AKG-28-5100.

Waste recovered from the treatment processes would be containerized and shipped to shore for disposal. Cooling water discharge is regulated through NPDES permits as established by Section 316(b) of the CWA. Once discharged, mixing, dilution, and dispersion of the wastes with large volumes of water would occur, and any impacts on water quality would be localized and temporary, and thus minor. Compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts to water quality. Based on the regulations outlined for the treatment and handling of bilge, ballast, fire water, and deck drainage, water quality may be temporarily affected by the Proposed Activity. The effects of these activities on water quality would be short-term and localized, and water quality would recover within a 24 hours after the discharge event or accidental release ceases, with minor impacts.

4.3.18.2. Air Pollutant and Greenhouse Gas Emissions

As outlined in Section 3.1.4.2, the air quality of Cook Inlet meets national standards. Air quality within the proposed Lease Sale Area is not regularly monitored in the same manner as in coastal areas. Trends in oil and gas production activity, which are reported annually by the ADNR Division of Oil and Gas, can be used to estimate changes in pollutant emissions from year to year. The 2014 annual report shows that oil and gas production in Cook Inlet has been increasing in recent years after a long period of decline. As of 2014, there were 30 active units and fields in Cook Inlet managed by the Division of Oil and Gas, mostly located to the north and east of the proposed Lease Sale Area. The impacts to air quality from the proposed seismic and geohazard/geotechnical surveys will be short-term and will dissipate quickly. Activities related to the installation and operation of two to three platforms (including service vessels and aircraft support) and the installation and operation of oil and gas pipelines will have a continuous impact over a longer period of time. These exploration and development activities will lead to an increase in criteria pollutant concentrations in the proposed Lease Sale Area (ADNR, 2015a).

Based on EPA Green Book monitoring records, as of November 2015, all coastal land areas surrounding the proposed Lease Sale Area are in attainment of the NAAQS for all criteria pollutants (EPA, 2015d). Air pollution resulting from the Proposed Action would be short-term and localized. The analysis of air quality effects of the Proposed Action indicates effects for air quality within Areas of Special Concern would be minor.

4.3.18.3. Physical Presence, Including Lights

Offshore lighting during the E&D Scenario phases primarily would be associated with drilling and construction operations. During production, platforms would also be a primary source of offshore lighting. Two to three new OCS platforms in Cook Inlet are anticipated under the Proposed

Action. Onshore lighting primarily would be associated with construction of new pipelines, access roads, and support facilities during the development phase, localized and temporary in duration. Lighting of onshore support facilities is also anticipated during development.

Offshore artificial lighting will occur from vessel operations involving seismic, geophysical, geohazard surveys along with vessel support operations during construction of pipelines. Survey vessels are continually moving, and individual surveys would be temporary and spatially limited within Cook Inlet. The activities that are part of the Proposed Action would occur at a minimum of 5.6 km (3 nmi) offshore, thus mitigating the impacts of artificial light and the presence of platforms.

Areas of Special Concern provide important habitats for a number of species. Species most sensitive to physical presence and possibly artificial light would be marine mammals, seabirds, and fish. Stipulations from prior lease sales have included changes to light direction and shading, where safe and feasible, to reduce disorientation of passing birds (USDOI, BOEM, 2011c; USDOI, MMS, 2007). Light directed inward and downward may be less likely to disorient birds than lighting schemes that radiate upward and outward. Derrick lights, deck lighting, doorway and stairway lighting, and pipe rack lighting are some of the lighting types that may be modified in this way to prevent or minimize impacts.

Given the number of lighted structures anticipated by the Proposed Action and the level of pre-existing vessel traffic in Cook Inlet, the impacts of lighting to the resources of the Areas of Special Concern is likely to be minimal. Two to three OCS platforms are expected to result from the Proposed Action. Because platforms illuminate only a small volume of water in the area, increased light irradiance would be localized and would not increase light pollution throughout the proposed Lease Sale Area. Light levels from all platforms will be eliminated after removal/decommissioning.

4.3.18.4. Aircraft Traffic and Noise

BOEM estimates that one to three helicopter flights per MODU per week may occur during exploration drilling, and one to three flights per platform per week may occur during the production phase.

If helicopter bases are located in Nikiski or Homer, Alaska, the main Areas of Special Concern that will be impacted in Cook Inlet will be the Alaska Maritime NWR, the Lake Clark NPP, and the Kachemak Bay NERR (Figure 3.3.9-1).

If aircraft need to fly over an Area of Special Concern, they would be expected to follow FAA (2004) guidance, which recommends a minimum altitude of 610 m (2,000 ft) when flying over noise sensitive areas such as national parks, wildlife refuges, and wilderness areas. When in transit offshore, helicopters typically maintain a minimum altitude of 213 m (700 ft). With adherence to FAA guidelines, and given the fact that helicopter flights are intermittent and short in duration (i.e., flight destinations and routes to and from platforms would be at least 5.6 km (3 nmi) offshore), the impacts for the resources within Areas of Special Concern are expected to be short term and localized, and thus minor.

The FAA overflight guidance is advisory only, and pilots-in-command may fly at any altitude required for the safe operation of flight. Typically, helicopters operate over Cook Inlet at altitudes below 305 m (1,000 ft) to avoid conflicts with fixed-wing aircraft operating at higher altitudes. Industry and agency managers at these protected areas could work to implement better helicopter and airplane management in the proposed Lease Sale Area. Industry could improve communication with local managers at these Areas of Special Concern regarding flying activities. Aircraft operators could avoid areas of high visitation or sensitive wildlife habitats or recreation areas during the most critical times of year. One mitigation measure could be to formalize existing altitude restrictions or increase minimum flight altitudes in discussions with managers at each protected area. Industry and agency land managers could engage in direct communication in the months in which managers have identified important resources as sensitive to noise and presence of aircraft to determine optimal schedules for flight operations that reduce adverse effects to Areas of Special Concern. Formal agreements and other measures designed to reduce effects require effective communication practices and relationship building to be successful (SRB&A, 2013). Permit stipulations for aircraft activities can be proposed.

4.3.18.5. Accidental Oil Spills and Gas Release

Accidental oil spills from offshore platforms or pipelines would affect Areas of Special Concern within and connected to Cook Inlet through the direct effect on water quality and potential oiling of coastal habitats within and contiguous to Cook Inlet. The magnitude of any effects would depend on the location and size of the spill, the type of product spilled, and weather conditions.

Small Oil Spills (<1,000 bbl)

Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and would be unlikely to affect Areas of Special Concern. Small spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products. Most accidental crude oil spills would be small and would have relatively small impacts on water quality and the associated marine resources. Impacts to Areas of Special Concern from small spills ≤50 bbl are expected to be negligible.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large spill of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours, and would be unlikely to affect Areas of Special Concern. Large spills of crude oil would persist longer in the environment and result in greater impacts than spills of refined products. Impacts from a large spill could result from chemicals used in the cleanup process. Impacts related to Areas of Special Concern would occur as impacts to water quality or impacts to the benthic resources that are important components of the Areas of Special Concern (e.g., marsh habitats, tidal mud flats, kelp habitats, oyster reefs) and could be major for large oil spills ≥1,000 bbl. The greatest potential for longer-term impacts to marine and coastal Areas of Special Concern resources would be associated with a large oil spill. In the unlikely event of a large spill, impacts to water quality and the coastal habitats of Cook Inlet could be severe. This degradation in water quality could cause sustained contamination of the coastal and marsh habitat throughout the Cook Inlet region (Figures 3.2.6-1 and 3.2.6-2). Following a large spill, crude oil impacts to Areas of Special Concern coastal habitats could be severe. A large oil spill could severely affect the benthic habitats and the ecological processes and food web of the marine coastal environment and the marine and terrestrial plants and animals that utilize Cook Inlet. The severity and spatial extent of these impacts from a large oil spill would depend on the spill size and composition, weather conditions, and the location of the spill. Overall, the effects of a large spill could be major for the biotic resources and human visitors associated with Areas of Special Concern.

BOEM estimates that a well control incident of a single well could occur under the Proposed Action, resulting in the release of 8 MMcf of natural gas in one day. Blowouts of natural gas condensates that did not burn would disperse rapidly at the blowout site; thus, it is unlikely that toxic fumes would affect Areas of Special Concern. In the case of a gas blowout that resulted in an explosion and fire, smoke could reach coastal Areas of Special Concern, but quick dispersion of air pollutants would result in negligible impacts.

Oil-spill Risk Analysis

Parks, refuges, and other protected areas in Cook Inlet and the surrounding region are represented in the OSRA model by LSs and GLSs listed in Table A.1-15 of Appendix A. A summary of the maximum percent chance that a large oil spill will contact these Areas of Special Concern within 3 and 30 days during summer and winter is provided in Table 4.3.2-27.

Table 4.3.2-27. Highest Percent Chance of a Large Oil Spill Contacting Areas of Special Concern[1]

OSRA Feature	Highest Percent Chance	Summer	Areas of Special Concern	Summer	Areas of Special Concern	Winter	Areas of Special Concern	Winter	Areas of Special Concern
		3 days		30 days[2]		3 days		30 days[2]	
Land Segment (LS)	≥0.5–<6	38	Kalgin Island CHA	38	Kalgin Island CHA	38	Kalgin Island CHA	38	Kalgin Island CHA
Land Segment (LS)	≥6–<25	35	Tuxedni Refuge	35	Tuxedni Refuge	35	Tuxedni Refuge	35	Tuxedni Refuge
Grouped Land Segment (GLS)	≥0.5–<6	123 126 130 139	Katmai NPP, McNeil River State Game Sanctuary and Refuge, Redoubt Bay CHA and Trading Bay SGR, Kachemak Bay State Park, Wilderness Park Kachemak Bay State Critical Habitat Area	113 114 122 130 139 143 158 164	Alaska Peninsula NWR, AMNWR SW Shelikof/ Gulf of Alaska, Becharof NWR, Redoubt Bay CHA and Trading Bay SGR, Kachemak Bay State Park, Wilderness Park Kachemak Bay State Critical Habitat Area, AMNWR W Outer Kenai/ Gulf of Alaska, Kodiak National Wildlife Refuge, Afognak Island State Park	123 126 130 138 143	Katmai NPS, McNeil River State Game Sanctuary and Refuge, Redoubt Bay CHA and Trading Bay SGR, Clam Gulch Critical Habitat, AMNWR W Outer Kenai/ Gulf of Alaska	114 122 130 139 143 158 161 164	AMNWR SW Shelikof/ Gulf of Alaska, Becharof NWR, Redoubt Bay CHA and Trading Bay SGR, Kachemak Bay State Park, Wilderness Park Kachemak Bay State Critical Habitat Area, AMNWR W Outer Kenai/ Gulf of Alaska, Kodiak National Wildlife Refuge, AMNWR S Kodiak/Gulf of Alaska and Tugidak Island Critical Habitat Area, Afognak Island State Park
Grouped Land Segment (GLS)	≥6–<24	135 138 142	Kenai AK State Rec Mgmt. Areas, Clam Gulch Critical Habitat, AMNWR E Cook Inlet	123 126 135 138 142 153 154 156	Katmai NPS, McNeil River State Game Sanctuary and Refuge, Kenai AK State Rec Mgmt. Areas, Clam Gulch Critical Habitat, AMNWR E Cook Inlet, Shuyak Island State Park, AMNWR Afognak and Shuyak Islands, Kodiak National Wildlife Refuge	135 142	Kenai AK State Rec Mgmt. Areas, AMNWR E Cook Inlet	123 126 135 138 142 153 154 156	Katmai NPS, McNeil River State Game Sanctuary and Refuge, Kenai AK State Rec Mgmt. Areas, Clam Gulch Critical Habitat, AMNWR E Cook Inlet, Shuyak Island State Park, AMNWR Afognak and Shuyak Islands, Kodiak National Wildlife Refuge
Grouped Land Segment (GLS)	≥25–<50	127 128	AMNWR W Cook Inlet, Lake Clark National Park and Preserve	128	Lake Clark National Park and Preserve	127 128	AMNWR W Cook Inlet, Lake Clark National Park and Preserve,	--	
Grouped Land Segment (GLS)	≥50	--		127	AMNWR W Cook Inlet	--		127 128	AMNWR W Cook Inlet, Lake Clark National Park and Preserve,

Notes: -- all percent chances of contact are <0.5.
[1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter with 100% chance of a large spill occurring. Note that only ERAs, LSs, and GLSs with percent chances of contact ≥0.5 are shown.
[2] Note that the highest percent chance contact within 30 days is the same as 110 days (Section 4.12) in both seasons, but the individual results from each LA or PL may not be identical.
Source: Appendix A (Tables A.1-15, A.2-27, A.2-29, A.2-32, A.2-34, A.2-47, A.2-49, A.2-52, and A.2-54). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

The OSRA analysis was run for three seasons: annual (January to December), winter (November to March), and summer (April to October). The OSRA model estimates that during summer, no Areas of Special Concern will be contacted within 3 days at ≥50% (Table 4.3.2-27). The OSRA 3-day summer scenario estimates that the chance of a large spill contacting Areas of Special Concern in the eastern and southeastern sections are lower than those located along the western and southwestern portion of Cook Inlet.

After 30 days in the summer scenario, one Area of Special Concern, the Alaska Maritime NWR along the western shoreline of Cook Inlet, which includes Tuxedni Bay and islands, has a ≥50% chance of contact by a large oil spill (Table 4.3.2-27). The percent chance of a large spill contacting areas within Cook Inlet decreases for the Areas of Special Concern located south of the proposed Lease Sale Area. Most of the Areas of Special Concern are aligned along the southeastern shoreline of the Alaska Peninsula and in the northern reaches of the Shelikof Straits.

Seasonal comparisons of probabilities of shoreline contact indicate only slight changes in the percent chance of contact for each LS and GLS (Table 4.3.2-27). In winter, no Areas of Special Concern are categorized within the conditional percent chance of ≥50% under the 3-day scenario. The 3-day scenario reflects the same oil contact probability pattern with a trending decrease; the farther south an Area of Special Concern is located from the proposed Lease Sale Area, the less the probability of oil contact would occur.

The 30-day winter scenario produced results similar to the 30-day summer scenario. Most of the differences in the GLSs and Areas of Special Concern estimated to be contacted are in areas contiguous and adjacent to habitats identified to be impacted in the summer OSRA model. One change in ≥50% category has GLSs 127 and 128 representing the Alaska Maritime NWR-W Cook Inlet and Lake Clark National Park and Preserve in this category.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources on Areas of Special Concern, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread.

4.3.18.6. Impact Conclusions

Overall, impacts from routine activities as a result of the Proposed Action would result in **minor** impacts to Areas of Special Concern due to potential short-term effects from discharges, greenhouse gas emissions, and aircraft traffic and noise. A small oil spill would result in **negligible** impacts to Areas of Special Concern due to the distance from shore and small area of contamination. In the unlikely event of a large oil spill, impacts to water quality and coastal habitats and natural resources of the Cook Inlet region are expected to be **major**. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for Areas of Special Concern for routine activities or accidental spills. Also, GUIE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for Areas of Special Concern with regard to routine activities.

4.3.19. Oil and Gas and Related Infrastructure

IPFs with the potential to affect oil and gas and related infrastructure are (1) seafloor disturbance and habitat alteration; and (2) accidental oil spills and gas releases.

4.3.19.1. Seafloor Disturbance and Habitat Alteration

Seafloor disturbance and habitat alteration is an IPF for oil and gas and related infrastructure due to the potential to impact existing submarine fiber optic cables in Cook Inlet (Section 3.4.1). Because the precise locations of all submarine fiber optic cables are well documented and readily available for the geohazards report, it is highly likely that personnel conducting geophysical work associated with oil and gas activities would have this information and take preventive measures to ensure that any seafloor disturbance does not impact these cables. In the remote chance any subsea disturbance did damage submarine cables, the anticipated impacts would only last as long as it took to repair the cables; thus, impacts would be expected to be localized and short-term, and thus minor.

4.3.19.2. Accidental Oil Spills and Gas Release

This analysis considers the accidental spills of refined products and crude oil and condensates that can occur from all phases of the Proposed Action.

Small Oil Spills (<1,000 bbl)

Small spills of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours and would be unlikely to affect existing oil and gas infrastructure. Small spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products. Small spills of crude oil or condensate could have short-term and localized impacts on existing oil and gas infrastructure if infrastructure such as rigs or platforms were in the immediate vicinity of the spill. However, due to the location of the proposed Lease Sale Area compared to existing oil and gas infrastructure in Cook Inlet, which is currently limited to state waters and lands, these small spills, individually and collectively, should have little to no impact on existing oil and gas infrastructure.

Large Oil Spill (≥1,000 bbl)/Gas Release

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. A large spill of refined oil (such as lube oil, hydraulic oil, gasoline, or diesel fuel) would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate within 24 hours, and would be unlikely to affect existing oil and gas infrastructure. A large spill of crude oil will persist longer in the environment and result in short-term and localized impacts to oil and gas and related infrastructure.

The highest potential for impacts from a large spill to submarine fiber optic cables would if a response vessel anchor snagged or became entangled with a cable that was no longer sufficiently buried, or for shoreline cleanup operations to potentially impact an area where the submarine cables came ashore. The likelihood of these scenarios occurring is considered low, and any resulting impacts would be temporary and localized. Overall, a large oil spill could have minor impacts on the oil and gas infrastructure, depending on the type and volume of oil spilled.

BOEM estimates that a well control incident of a single well could occur under the Proposed Action, resulting in the release of 8 MMcf of natural gas in one day. A gas release would be expected to dissipate rapidly and have no impacts on existing oil and gas and related infrastructure. A large gas release that resulted in an explosion and fire could result in temporary disruptions to ongoing service vessel trips to existing oil and gas and related infrastructure in Cook Inlet. Overall, a gas release is not expected to have negligible impacts on existing oil and gas and related infrastructure.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%.

Spill Response Activities

Spill response activities could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time and extent of response activities could be short-term and localized or long lasting and widespread.

Mechanical containment and recovery and possibly dispersants and in situ burning will likely result in the USCG, as the Federal On-Scene Coordinator, restricting vessel traffic in Cook Inlet in the areas of oil movement and cleanup operations. These restrictions could have an impact to existing Cook Inlet oil and gas operations and infrastructure, as they could result in support vessels not being able to service ongoing offshore oil and gas activities. For a large crude oil spill of 5,100 bbl from an offshore platform, airspace above and around the spill response operations could be temporarily restricted, which could result in diverted or canceled flights to other oil and gas rigs in Cook Inlet. Onshore oil and gas activities would be relatively unaffected by such vessel and aircraft restrictions.

4.3.19.3. Impact Conclusions

Overall, the effects of routine activities from the Proposed Action on oil and gas and related infrastructure would be **negligible**. Impacts from small spills on oil and gas and related infrastructure would be **negligible**. Large spills could result in **minor** impacts to oil and gas and related infrastructure, primarily due to temporary area closures as a result of spill cleanup operations that could impact supply vessels rigs, or other infrastructure in Cook Inlet. Oil spill response practices described in Section 4.2.14.3 are not expected to alter impact conclusions for oil and gas and related infrastructure for routine activities or accidental spills. Also, GUIE (oil spill drills), which are infrequent, of short duration, (<8 hours), and utilize existing equipment, would not alter impact conclusions for oil and gas and related infrastructure with regard to routine activities.

4.3.20. Environmental Justice

The intent of the environmental justice policy, as written in 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 (i.e., adverse) effects from a country's domestic and foreign programs. BOEM recognizes that the potential impacts of the Proposed Action within minority populations, low-income populations, or Indian tribes may be different from impacts on the general population of the proposed Lease Sale Area due to a community's distinct cultural practices (CEQ, 1997a).

Executive Order 12898 requires an evaluation in the EIS as to whether the Proposed Action would have disproportionately high and adverse human health and environmental effects on a minority population, a low income population, or Indian tribe (CEQ, 1997a). Analysis of the impacts of the Proposed Action on environmental justice communities follows guidelines described in the CEQ's (1997a) Environmental Justice Guidance under the NEPA. The analysis method has three parts:

- A description of the geographic distribution of low-income and minority populations or Indian tribes in the affected area is written (see Sections 3.3.4.1, 3.3.4.2, and 3.3.10 and Table 3.3.10-1).
- An assessment is conducted to determine whether the Proposed Action would produce impacts that are high and adverse (i.e., major and adverse) (see Sections 4.3.12, 4.3.13, and 4.3.14 and Table 2.8.7-1).
- If impacts are identified to be high and adverse, a determination is made as to whether these impacts would disproportionately affect low-income and minority populations or Indian tribes in the affected area (i.e., environmental justice communities).

Minority populations were identified where either: (a) the minority population of the affected area exceeds 50% or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or some other appropriate reference population (CEQ, 1997a). The Alaska statewide population is approximately 20% American Indian and

Alaska Native, a recognized minority group (CEQ, 1997) (ADLWD, 2016). For the Kenai Peninsula Borough as a whole, the American Indian and Alaska Native population is approximately 7% (ADLWD, 2015b).

The communities in Table 3.3.10-1 have a meaningfully higher percentage of Alaska Native peoples living in them than the Kenai Peninsula Borough as a whole, and all but one, Ninilchik, have a meaningfully higher percentage of Alaska Native peoples living in them than the state of Alaska as a whole. Moreover, for all but two of these communities, Ninilchik and Seldovia Village, the minority Alaska Native population exceeds 50% of the total community population.

Based on the percentage of American Indian and Alaska Natives residents, BOEM has identified environmental justice communities to include: Port Graham, Seldovia Village, Nanwalek, Ninilchik, Chignik Bay, Chignik Lagoon, Chignik Lake, Perryville, Ivanof Bay, Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, Port Lions, and Tyonek (Table 3.3.10-1). This environmental justice analysis also includes the Dena'ina (Kenaitze) Indian population and the Salamatof population in the Kenai-Soldotna-Nikiski area because they are Federally-recognized Indian tribes living in the proposed Lease Sale Area (CEQ, 1997). Sections 3.3.4.1 and 3.3.4.2 and Table 3.3.4-2 describe the populations and social characteristics for the environmental justice communities.

Low income commonly correlates with Alaska Native subsistence-based communities in coastal and rural Alaska; however, the communities listed above and displayed in Table 3.3.10-1 qualify as environmental justice communities based on their racial/ethnic minority composition alone. Income level was not used in this environmental justice analysis to identify environmental justice communities.

In environmental justice analyses, Federal agencies are also directed to analyze information on patterns of subsistence consumption of fish and wildlife (CEQ, 1997a); any high and adverse environmental effects to fish and wildlife from the Proposed Action could disproportionately impact those communities or populations that depend most on those resources (e.g., inability to obtain migratory subsistence resources due to their unavailability; contaminants in subsistence foods or perceptions of contamination; and loss of access to hunting grounds and fishing areas). Sections 3.3.3.5 and 3.3.4.3 describe subsistence use patterns and dependence on fish and wildlife resources for communities in the proposed Lease Sale Area.

Analysis of the impacts of the Proposed Action and alternatives in Chapter 4 found no major (i.e., high and adverse) impacts for routine activities or small spills for any subsistence resource, subsistence harvest patterns, public and community health, or sociocultural systems (see Table 2.8.7-1). When a Federal agency conducts an environmental justice analysis under the NEPA, it only considers high and adverse impacts to minority and low-income populations or Indian tribes (CEQ, 1997a). (A high level impact is equated with a major impact as defined in this EIS or a significant impact as defined in NEPA). Routine activities and small spills associated with the Proposed Action and alternatives do not apply in this environmental justice analysis because BOEM anticipates no major (i.e., high and adverse) impacts from these. This environmental justice analysis examined large spills associated with the Proposed Action and alternatives. Where impacts from large spills are anticipated to be high and adverse, disproportionality of those impacts on environmental justice communities is determined by comparing environmental justice communities to non-environmental justice communities in the proposed Lease Sale Area in relation to those high and adverse impacts (see Section 4.3.20.1, Large Oil Spill).

4.3.20.1. Accidental Oil Spills

Accidental spills associated with proposed Lease Sale 244 could affect environmental justice communities during all phases of the E&D Scenario, depending on the spill type, source, and spill size. Spills that may occur during oil and gas activities in conjunction with the Proposed Action include gas releases, small oil spills (<1,000 bbl), and large oil spills (≥1,000 bbl) of refined or crude oil. In this environmental justice analysis, BOEM only considered large spills because no high and adverse (i.e., major) impacts are anticipated to occur from gas releases and small spills associated with the Proposed Action and alternatives (see Table 2.8.7-1).

Large Oil Spill (≥1,000 bbl)

Although unlikely, for purposes of analysis, BOEM estimates that a large spill involving a platform or offshore or onshore pipeline could result in the release of 5,100, 1,700 or 2,500 bbl, respectively. As summarized and discussed in Section 4.2.14, one large spill is estimated to occur under the Proposed Action.

A large oil spill may occur during all phases of the E&D Scenario; however, such spills are more likely to occur during development and production with wells, pipelines, and platforms being the most common sources of oil entering the environment. BOEM assumes that crude oil spills (1,700 and 5,100 bbl) could last up to 30 days on the water as a coherent slick. Appendix A (Tables A.1-3 through A.1-5) displays the fate and behavior of crude oil spills under three seasonal constraints. Duration of the impact of a large spill is expected to be long-term, depending on what volume of oil reaches the shore and exposed resources and how long it persists in the environment. A large spill would most likely have disproportionately high and adverse effects on environmental justice communities caused by major impacts to environmental resources important for subsistence purposes.

The OSRA conditional probability tables in Appendix A estimate an 8% chance of a large spill contacting LS 62 (Nanwalek, Port Graham) within 30 days, during the annual and summer seasons, assuming a spill ≥1,000 bbl occurs at LA 6. The combined probability of one or more large spills occurring and contacting ERA 62 (Nanwalek, Port Graham) is <0.5% within 3 days and 1% within 30 days. All other areas associated with environmental justice communities had combined probabilities of less than 0.5%.

A large spill is expected to have adverse and major impacts on subsistence harvest patterns and sociocultural systems. A large spill is also expected to have high and adverse impacts on birds, coastal and estuarine habitats, and Areas of Special Concern such as national wildlife refuges and preserves, which are each important for subsistence activities for environmental justice communities (see Table 2.8.7-1 for a summary of impacts). BOEM anticipates that these impacts will disproportionally affect environmental justice communities in the impact zone of a large oil spill because these communities are more dependent on wild food production and distribution than the non-environmental justice communities in the proposed Lease Sale Area (see Table 3.3.4-2). For example, environmental justice communities rely more on marine resources such as invertebrates, fish and shellfish, and marine mammals for subsistence purposes than nonminority, non-subsistence-based communities in the proposed Lease Sale Area. Fish and shellfish (Section 4.3.5.9) and marine mammals (Section 4.3.6.9) are expected to be adversely and moderately impacted by large oil spills.

Large oil spills could result in contamination of subsistence foods and the perception of tainting of important marine resources. Real and perceived contamination and damage to marine resources would most likely cause disproportionately high and adverse effects to community health and wellbeing for environmental justice communities and Indian tribes living in the proposed Lease Sale Area. These effects would arise from distress and disruptions to social patterns and community cohesiveness that would be greater in extent and magnitude for environmental justice communities than non-environmental justice communities.

Impacts of large spills on public and community health are expected to be long lasting and widespread, and thus moderate for the Kenai Peninsula Borough as a whole but are anticipated to be disproportionately high and adverse for environmental justice communities due to their distinct cultural practices and subsistence ways of life. In the event that a large oil spill occurred and contaminated essential subsistence resources and harvest areas, disproportionately high and adverse effects could occur in environmental justice communities, especially when impacts from contamination of the shoreline, tainting concerns, spill response and cleanup disturbance, disruption of subsistence practices, and climate change are factored together.

Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a large spill from any LA or PL has a <0.5% to 2% chance of contacting resources as far south as Shelikof Strait and east of Kodiak Island within 30 days, assuming a large spill occurs. The combined results estimate the chance of one or more large spills occurring and contacting these areas range from <0.5% to 2%. High and adverse (i.e., major) effects from large spills on subsistence resources or practices could impact sociocultural systems, public health, and subsistence harvest patterns, and would most likely be disproportionately experienced by environmental justice communities. Specific analysis of impacts to subsistence harvest patterns, sociocultural systems, and public and community health are discussed in Sections 4.3.12, 4.3.13, and 4.3.14, respectively.

Spill Response Activities

Spill response activities for a large spill event could include mechanical recovery methods, use of dispersants, and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations. Depending on the size of the spill and whether or not it contacted intertidal and onshore resources, response and cleanup time could be short-term and localized or long lasting and widespread.

Subsistence harvest, processing and sharing are the foundations of sociocultural systems in these environmental justice communities. If spill response and clean-up operations include sections of the beach, or intertidal zones, access to subsistence fishing and shellfishing areas and areas used for coastal subsistence hunting of terrestrial mammals could be temporarily disrupted by cleanup activities or restricted by regulators due to conservation and species recovery issues. If environmental justice communities lost access to these subsistence resources for one or more seasons, they would be adversely affected more so that non-environmental justice communities in the impact zone of the spill. This is because their economic development is more dependent on the subsistence sector than non-subsistence-based, predominantly non-minority communities, which have higher levels of wage and market economic development (Table 3.3.4-2). Environmental justice communities are dependent on production and distribution of wild subsistence foods more than non-subsistence based communities in the proposed Lease Sale Area (see Table 3.3.4-2).

Impacts to social patterns, sharing networks, community capacity and organization, local institutions, and cultural values and identities caused by spill response and cleanup activities are expected to be disproportionately high and adverse for environmental justice communities depending on the extent and location of the large spill and to what extent subsistence harvest patterns are disrupted. These sociocultural aspects of environmental justice communities would be adversely affected more so than non-environmental justice communities in the impact zone of the spill because they depend more on production and distribution of wild subsistence foods and have higher levels of extended kinship and tribal organization than non-subsistence based communities in the proposed Lease Sale Area (see Table 3.3.4-2).

4.3.20.2. Impact Conclusions

Subsistence remains an important part of the socio-economic and sociocultural systems of rural Alaska (Fall, 2016). The environmental justice communities in Table 3.3.10-1 have mixed subsistence-cash economies with subsistence meeting various cultural, social, and nutritional needs. People living in these environmental justice communities obtain much of their food directly from lands and waters, including subsistence harvest of salmon.

In addition to the economic importance of subsistence, it is a vital part of Alaska Native cultures, identities, and ways of life for these environmental justice communities (Knapp, 2012). Subsistence resources provide more than dietary benefits. They also provide materials for personal and family use, and sharing resources helps maintain traditional family and community organization (Boraas, 2013). Subsistence resources provide special foods for religious and social occasions. Sharing, trading, and bartering of subsistence foods structures relationships within and between communities, and giving of such foods helps maintain ties with family members elsewhere in Alaska (Magdanz et al., 2007).

Subsistence activities are assigned the highest cultural values by Cook Inlet Dena'ina, Alutiiq, and Koniag peoples, and provide a sense of identity in addition to being an important economic pursuit. Many marine and terrestrial species are important for the role they play in the annual cycle of subsistence harvests. Impacts from a large spill are anticipated to be greater in extent and magnitude for environmental justice communities than for predominantly non-Alaska Native communities in the proposed Lease Sale Area. This is primarily due to the anticipated major impacts of large spills on coastal habitats and Areas of Special Concern where environmental justice communities hunt and fish. Impacts of large spills on subsistence harvest patterns and sociocultural systems are anticipated to be major. A large spill would most likely have disproportionately high and adverse environmental and health effects on Alaskan Native peoples living in environmental justice communities in the proposed Lease Sale Area.

BOEM expects that a large spill would have environmental justice impacts. BOEM believes that effective mitigation for environmental justice impacts begins with a commitment to preventing spills in the first place by employing the highest standards for exploration, development, and production technology.

4.4. Alternative 2 – No Action

4.4.1. Regional Effects of the No Action Alternative

Under Alternative 2, Lease Sale 244 would not be held. Should this occur, no exploration, development, or production activities would occur in the proposed Lease Sale Area. If the estimated 150 to 215 MMbbl of oil and 81 to 571 Bcf of gas are not produced, there would be no chance of oil spills or gas releases occurring from wells, platforms, or pipelines resulting from Lease Sale 244 activities. All of the seafloor disturbance and habitat alteration, waste discharges, air emissions, noise, and other potential impact sources from OCS oil and gas activities discussed in Section 4.3 would be delayed or eliminated. Biological and socioeconomic resources in Cook Inlet could still be exposed to potential impacts from other ongoing oil and gas development activities in state waters.

The potential economic benefits that would occur under the Proposed Action, as discussed in Section 4.3.10, would not occur via Lease Sale 244 under the No Action Alternative. The economic benefits that would be delayed or not occur include direct and indirect wage earnings, taxes, and royalties collected by the State of Alaska and the Federal Government, and property taxes collected by the State of Alaska for assets such as onshore pipelines.

4.4.2. Possible Substitutes for Lost or Delayed Oil and Gas Production

To replace the potential production of an estimated 150 to 215 MMbbl of oil and 81 to 571 Bcf of gas that BOEM estimates could be produced from the Proposed Action, equivalent volumes would need to be produced from other sources, including domestic or imported oil and gas. In 2014, the U.S. consumed approximately 19.1 MMbbl per day of petroleum products (U.S. Department of Energy 2015a). At peak production, BOEM estimates production in Cook Inlet from the Proposed Action to be 68,000 bbl per day of oil, or approximately 0.35% of total U.S. demand.

The 2012-2017 OCS Oil and Gas Leasing Programmatic EIS (USDOI, BOEM, 2012b) estimates that other energy substitutes under the No Action Alternative would include substitute sources that could replace oil and gas not produced in Cook Inlet. These could be domestic oil production from other locations, imported oil, biofuels production, nuclear power, hydroelectric power, or other renewable energy sources such as tidal or wind produced electricity, or reduced demand to due energy conservation.

It is likely that the majority of the oil and gas used as to replace the lost oil and gas from Cook Inlet would be imported or sourced from other domestic locations. In 2014, net imports of petroleum into the U.S. were 5.07 MMbbl per day, or approximately 27% of domestic demand (U.S. Department of Energy, 2015b). The 2012-2017 OCS Oil and Gas Leasing Programmatic EIS (USDOI, BOEM, 2012b) estimates that imported petroleum products would be the major source of replacement energy under the No Action Alternative, with 52% to 62% of total replacement energy originating from additional oil imports and 8% to 9% of total replacement energy originating from additional gas imports. Assuming a mean imported replacement percent of 57% for oil, an additional 85.5 to 122.6 MMbbl of oil would need to be imported to replace lost oil production expected to occur because of the Proposed Action.

4.4.3. Environmental Impacts from the Most Important Substitutes

The 2012-2017 OCS Oil and Gas Leasing Programmatic EIS (USDOI, BOEM, 2012b) identified additional imported oil as the major source of replacement energy under the No Action Alternative. Furthermore, the E&D Scenario presented in Section 2.4 assumes that because a developed oil and gas market is present in the Cook Inlet Planning Area, oil and gas produced from the Proposed Action would be consumed locally. Thus, the most logical replacement for lost or delayed oil and gas due to selection of the No Action Alternative would be additional imports or additional domestic production. These substitutes, along with reduced demand, are briefly addressed in the following sections because they are the most likely sources of replacement energy should the No Action Alternative be selected for Lease Sale 244. Other replacement sources such as biofuels production, nuclear power, hydroelectric power, or other renewable energy sources such as tidal or wind produced electricity would not likely contribute enough replacement energy for lost or delayed oil and gas production from Cook Inlet. If alternative replacement sources were proposed as a result of the No Action Alternative, each would have their own environmental and socioeconomic impacts that could displace impacts from the Proposed Action to other geographic areas and resources. A detailed analysis of these impacts is beyond the scope of this EIS.

4.4.3.1. Additional Imports

The production of oil in countries other than the U.S. could result in environmental impacts similar to those discussed under the Proposed Action in Section 4.3, but would occur outside of the U.S. The species of animals, plants, and other organisms that would be affected would likely be different, depending on the location of the oil production. Some effects could still occur in Cook Inlet (and elsewhere in U.S. waters), depending on location of terminals for oil import by tanker. Assuming an average oil tanker carries approximately 1 MMbbl, an additional 86 to 123 tanker trips through U.S. waters could occur to import oil as replacement energy for lost Cook Inlet oil production. Environmental effects from additional imports could include additional air emissions and pollutants from transportation and dockside activities, degradation of water quality, and habitat alteration of degradation in areas affected by potential spills.

4.4.3.2. Additional Domestic Production

Additional offshore domestic oil and gas production would have similar impacts to those discussed in Section 4.3, but they would occur in a different location. Additional onshore domestic production also has the potential to cause environmental impacts to surface water, groundwater, and terrestrial habitats.

4.4.3.3. Reduced Demand

The 2012-2017 OCS Oil and Gas Leasing Programmatic EIS (USDOI, BOEM, 2012b) estimates that reduced demand due to energy conservation could replace approximately 6% of total energy substitutions for oil and gas under the No Action Alternative. Reduced energy demand could be realized due to increased fuel efficiency in vehicles and aircraft, reduced consumption, implementation of existing alternative energy techniques, and the development of new energy efficient technologies.

4.5. Alternatives 3A, 3B, and 3C – Beluga Whale Critical Habitat Exclusion, Critical Habitat Mitigation, or Nearshore Feeding Areas Mitigation

Alternative 3A would exclude 10 OCS blocks from proposed Lease Sale 244 that overlap with critical habitat for the Cook Inlet beluga whale, resulting in 214 OCS blocks offered for lease. Alternative 3B would require additional mitigation in 10 OCS blocks that overlap with critical habitat for the Cook Inlet beluga whale, resulting in 224 OCS blocks offered for lease (Figure 2.2.3-1). The 10 OCS blocks overlap with the Area 2 beluga whale critical habitat (OPD NP05-08 6759, 6760, 6808, 6809, 6810, 6811, 6858, 6859, 6860, and 6861) at the northern tip of the proposed Lease Sale Area. The areal extent of the affected OCS blocks is 11,887 ha (29,372 ac), or 2.68% of the proposed Lease Sale Area. The beluga whale critical habitat occurring within the excluded OCS blocks represents approximately 0.85% of the total area of the beluga whale critical habitat and 1.20% of the “Area 2” beluga whale critical habitat. Alternative 3C would offer 224 OCS blocks for lease with seasonal mitigation to protect beluga whales. Certain seasonal mitigations would be applied to all 224 OCS blocks between November 1 and April 1. Additional mitigation would be applied to the 146 OCS blocks located wholly or partially within 10 miles of major anadromous streams. Detailed descriptions of Alternatives 3A, 3B, and 3C are presented in Section 2.2.3. Potential impacts of Alternatives 3A, 3B, and 3C, by resource, are described in the subsections below.

4.5.1. Air Quality

Potential impacts on air quality under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.1. Air quality in the 10 blocks affected by these alternatives is expected to be similar to that in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. The geographic exclusion would not prevent emissions sources from being built in the proximity of sensitive Class I areas such as the Tuxedni National Wilderness Area, which could still be affected by emissions sources. Requiring additional mitigation in the blocks (Alternatives 3B and 3C) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM’s review of EPs and DPPs. Depending on the schedule of seismic surveys and exploration drilling, the time-of-year exclusions in Alternatives 3B and 3C could increase emissions between April 1 and November 1 that would otherwise have been more spread out during the year.

Conclusion for Alternative 3A: Impacts of Alternative 3A on air quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **minor** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on air quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **minor** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on air quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **minor** for a large spill.

4.5.2. Water Quality

Potential impacts on water quality under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.2. Water quality in the 10 blocks affected by these alternatives is expected to be similar to that in the rest of the proposed Lease Sale Area.

Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic surveys and exploration activities and may involve additional restrictions on activities based on BOEM's review of any resulting EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on water quality evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on water quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on water quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on water quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.5.3. Acoustic Environments

Potential impacts on acoustic environments under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.3. The acoustic environment in the 10 blocks affected by these alternatives is expected to be similar to that in the rest of the proposed Lease Sale Area. Impacts to the acoustic environment are the result of sound propagation through the water based on the level of development activity, which is not expected to change with these Alternatives. Exclusion of the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on the acoustic environments evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on acoustic environments would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on acoustic environments would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on acoustic environments would be less than those described for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for large spills.

4.5.4. Lower Trophic Level Organisms

Potential impacts on lower trophic level organisms under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.4. Water column and benthic communities in the 10 blocks affected by these alternatives are expected to be similar to those in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic surveys and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise from platforms near major anadromous streams (Alternative 3C) would eliminate or decrease the impact of proposed seismic sounds for a large part of the year. However, none of these factors would be expected to change the likelihood or severity of overall impacts on lower trophic level organisms evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on lower trophic level organisms would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for large spills.

Conclusion for Alternative 3B: Impacts of Alternative 3B on lower trophic level organisms would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for large spills.

Conclusion for Alternative 3C: Impacts of Alternative 3C on lower trophic level organisms would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for large spills.

4.5.5. Fish and Shellfish

Potential impacts on fish and shellfish under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.5. Fish and shellfish in the 10 blocks affected by these alternatives are expected to be similar to those in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic surveys and exploration activities and may involve additional restrictions on activities based on BOEM review of EPs and DPPs. Limiting seismic surveys near major anadromous streams (Alternative 3C) would eliminate or decrease the negative effects of noise on spawning fish that use those streams. This alternative would protect spawning salmon moving into anadromous waters, from seismic noise effects at the beginning and end of the spawning season. Only seismic activity occurring in September is likely to affect spawning salmon in this alternative. However, none of these factors would be expected to change the likelihood or severity of overall impacts on fish and shellfish evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on fish and shellfish would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on fish and shellfish would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on fish and shellfish would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for large spills.

4.5.6. Marine Mammals

Under Alternative 3A, 10 OCS blocks that overlap "Area 2" critical habitat for Cook Inlet beluga whales would be excluded from offering in the proposed Lease Sale Area, and all potential on-lease activities within those blocks would be eliminated. Generally, beluga whales spend the ice-free months in upper Cook Inlet (often at discrete high-use areas near river mouths), then expand their distribution south and into more offshore waters of middle Cook Inlet in winter, although they may be found throughout Cook Inlet at any time of year (Ferguson, Curtis, and Harrison, 2015; NMFS, 2015a) The "Area 2" portion of the Cook Inlet beluga whale critical habitat overlaps with the proposed Lease Sale Area and largely consists of dispersed fall and winter feeding and transit areas in waters where whales typically occur in lower densities or deeper waters than in "Area 1" critical habitat.

The beluga whale critical habitat occurring within the excluded area represents approximately 0.85% of the total area of the beluga whale critical habitat and 1.2% of the "Area 2" critical habitat. No exploration and development drilling or platform construction would occur within the corridor. However, the area within the excluded blocks would still be exposed to potential stressors and risks from activities associated with the Proposed Action in the remainder of the proposed Lease Sale Area. Examples include underwater noise (e.g., from seismic surveys vessel traffic and drilling activities in other blocks), vessel traffic, and accidental spills.

Excluding the beluga whale critical habitat was identified as an alternative (Alternative 3A) based on scoping comments from NMFS and the Marine Mammal Commission (MMC). Excluding the beluga whale critical habitat area would protect the habitat from adverse effects of potential oil and gas development, especially in the winter months when beluga whales are utilizing critical habitat that overlaps with the proposed Lease Sale Area. As far-reaching effects to marine mammals from some of the IPFs associated with the Proposed Action (e.g., physical presence, oil spills, underwater sound, vessel, air traffic) are possible, removal of these blocks from the proposed Lease Sale Area may not entirely eliminate impacts from activities in nearby OCS blocks.

Accidental spills (specifically, large spills), vessel/air traffic, and underwater noise were identified as having the greatest potential impact to marine mammals. These IPFs will likely all have adverse impacts on primary constituent elements (PCEs) 2, 3, 4, and 5. The overall effects Alternative 3A has on the IPFs affecting these primary constituent elements are discussed here.

The exclusion of beluga whale critical habitat blocks under Alternative 3A would reduce the potential for interactions between beluga whales and OCS oil and gas activities in those blocks. Sources of underwater noise and disturbance, including on lease seismic surveys, construction activities, vessels, and drilling and production operations, would be eliminated from the blocks. Beluga whales (and other marine mammals) could be exposed to noise from activities in adjacent blocks, but at greater distances from the sources. Support vessels and helicopters may pass through the blocks, particularly if Nikiski is used as a shore base. Excluding the blocks would not change the overall level of activity under the E&D Scenario, and therefore would not change the risk of accidental spills. However, because the excluded blocks are at the northern tip of the proposed Lease Sale Area, elimination of these blocks would increase the distance by approximately 9.6 km (6 mi) between potential OCS spill sources and the Area 1 critical habitat located at the northern end of Cook Inlet. Finally, excluding the critical habitat blocks would not substantially change the risk or severity of impacts on beluga whales or any other marine mammals occurring in the remainder of the proposed Lease Sale Area. Marine mammal prey species are widely distributed and not limited to critical habitat blocks, and so may still be exposed to oil and adversely affect marine mammals through ingestion of contaminated prey, or further affect their fitness through reduced quantity, quality, or altered location of prey species affected by oil. As a large oil spill has been projected to move throughout various areas in Cook Inlet (see Tables 4.3.2-15 to 4.3.2-17), inside and outside of critical habitat, marine mammals would still be vulnerable oil exposure, even under Alternative 3A.

The primary benefit to marine mammals of the corridor provided by Alternative 3A is that it would move potential sources of noise and vessel traffic away from Cook Inlet beluga whale critical habitat areas. As described in Section 4.3.6.2, noise from oil and gas activities may affect marine mammals in various ways, including (1) disruption of behavior (e.g., feeding, breeding, resting, migration), (2) masking of important sounds, (3) temporary or permanent hearing loss, (4) physiological stress or physical injury, and (5) changes to the ecosystems that result in a reduction of prey availability (Southall et al., 2007). The 2015 Draft Cook Inlet Beluga Recovery Plan (NMFS, 2015a) lists noise as a potential threat to the recovery of Cook Inlet beluga whales, with a “high” relative concern (as compared to other threats). A PCE of Cook Inlet beluga whale critical habitat is waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales. The absence of or increased distance between these sounds and marine mammals will likely reduce or eliminate the effects of underwater noise on marine mammals that use this critical habitat.

Under Alternative 3A, vessel traffic from the Proposed Action would be reduced through Cook Inlet beluga whale critical habitat; however, Alternative 3A would not prohibit vessel traffic through the critical habitat blocks and some impacts from vessel traffic could still occur.

Under Alternative 3B, certain activities would be restricted in months when beluga whales are more likely to be present. This mitigation alternative was based on an analysis conducted using the PCEs deemed essential to the conservation of the Cook Inlet beluga whale as identified in the critical habitat designation. Briefly, the PCEs of critical habitat include:

- Intertidal and subtidal waters of Cook Inlet with depths <9.1 m (30 ft) (MLLW) and within 8 km (5 mi) of high- and medium-flow anadromous fish streams.
- Primary prey species consisting of four species of Pacific salmon (chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.
- Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.
- Unrestricted passage within or between critical habitat areas.
- Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.

Under Alternative 3B, the beluga whale critical habitat blocks would be included in Lease Sale 244, but lessees would not conduct on-lease seismic surveys or exploration drilling between November 1 and April 1 when beluga whales are most likely to be present in these blocks. Lessees may request a waiver from or variance to this stipulation at the time of filing an EP with the RSLP and providing the method, and an analysis evaluating the method, of protecting the beluga whale critical habitat from the specified activities in the EP.

The scheduling restrictions on seismic surveys and exploration activities may reduce the likelihood of interactions between beluga whales and OCS oil and gas activities from November to April. To the extent that seismic and exploration surveys might be scheduled during these months, the timing restriction would prevent exposure to sources of underwater noise and disturbance, including on-lease seismic surveys and exploration drilling. In practice, the schedule restriction may have little effect because most seismic surveys and exploration drilling are expected to occur during summer and early fall. In addition, Alternative 3B would not restrict the scheduling of development and production activities. Beluga whales (and other marine mammals) could be exposed to noise from activities in adjacent blocks during any time of year, but at greater distances from the sources. Support vessels and helicopters may pass through the blocks, particularly if Nikiski is used as a shore base. The timing restrictions would not change the risks or impacts of accidental spills. Finally, the timing restrictions would not meaningfully change the risk or severity of impacts on beluga whales or other marine mammals occurring in the remainder of the proposed Lease Sale Area.

Under Alternative 3C, all blocks proposed under the Proposed Action would be offered for lease with seasonal mitigation to protect beluga whales. Certain seasonal mitigations would be applied to all 224 OCS blocks between November 1 and April 1. Additional mitigation would be applied to the 146 OCS blocks located wholly or partially within 10 miles of major anadromous streams.

Under Alternative 3C, on all 224 OCS blocks, no on-lease marine seismic surveys would be conducted between November 1 and April 1 when beluga whales are most likely to be present and distributed across the Lease Sale Area. For blocks within 10 miles of major anadromous streams, no on-lease marine seismic surveys would be conducted between July 1 and September 30 (when beluga whales are migrating to and from their summer feeding areas). Lessees may request a waiver from or variance to these stipulations at the time of filing an exploration or a development and production plan with the RSLP and provide the method, and an analysis evaluating the method, of protecting the beluga whales from the specified activities in the plan. Such requests must identify alternative methods for providing commensurate protection of beluga whales, and analyze the effectiveness of those methods.

While not specifically proposed in scoping comments, Alternative 3C was developed by BOEM analysts during preparation of the Draft EIS to further address concerns about potential impacts to beluga whales.

In recent IHAs concerning oil and gas activities in Cook Inlet, NMFS required rigorous mitigation measures to achieve the least practicable impacts on Cook Inlet beluga whales and other marine mammals, including restricting activities within 10 mi (16 km) of the Susitna Delta from April 15 through October 15 (NMFS, 2015f). This measure was designed to avoid any effects to belugas in an important feeding and breeding area. Alternative 3C builds on that rationale by expanding the 10 mi restricted area concept to the anadromous streams near the proposed Lease Sale Area that may function as feeding areas for beluga whales.

The criteria that NMFS used to define the buffer size at 10 mi (16 km) was based on modeling data for 1, 760 in3 seismic airgun arrays suggesting noise ≥160 dB travels in a radius of around 5.9 mi (9 km) (80 *FR* 29162, May 20, 2015). The 10 mi area included the estimated 5.9 mi for the airgun array noise to attenuate down to 160 dB (the MMPA Level B Harassment threshold for impulsive sound), plus an additional 4.1 mi buffer to further reduce both the scope and severity of potential impacts to Cook Inlet beluga whales in those areas.

Conclusion for Alternative 3A: Excluding the beluga whale critical habitat area would slightly reduce the risk of impacts on beluga whales relative to Alternative 1 (Proposed Action), especially in the winter months when relatively larger numbers of beluga whales are utilizing critical habitat that overlaps with the proposed Lease Sale Area. However, the overall impact ratings for marine mammals remain unchanged: **minor** for routine activities, **negligible effect** for small spills, and **moderate** for a large spill without any mitigations. With the standard suite of NMFS and USFWS mitigations there should be a negligible to minor level of effects to marine mammals from routine activities, negligible effect from small spills, and a negligible level of effects from large spills for all marine mammals other than sea otters. Sea otters would experience a moderate level of effects from a large spill due to the severe adverse effects oiling often has on the insulative integrity of their fur.

Conclusion for Alternative 3B: Alternative 3B would slightly reduce the risk of impacts on beluga whales relative to Alternative 1 (Proposed Action). Alternative 3B would be less effective than Alternative 3A in reducing impacts because the scheduling restriction for seismic surveys and exploration activities is likely to have little practical effect, and development and production activities would not be eliminated. Mitigation outlined under this alternative would not protect marine mammals from potential adverse impacts of an oil spill. The overall impact ratings for marine mammals remain unchanged: **minor** for routine activities, **negligible effect** for small spills, and **moderate** for a large spill without any mitigations. With the standard suite of NMFS and USFWS mitigations there should be a negligible to minor level of effects to marine mammals from routine activities, negligible effect from small spills, and a negligible level of effects from large spills for all marine mammals other than sea otters. Sea otters would experience a moderate level of effects from a large spill due to the severe adverse effects oiling often has on the insulative integrity of their fur.

Conclusion for Alternative 3C: Alternative 3C would slightly reduce the risk of impacts to beluga whales, Steller sea lions, harbor seals, and sea otters relative to Alternative 1 (Proposed Action). Alternative 3C would be more effective than Alternative 3A or Alternative 3B in reducing noise impacts on marine mammals because of the greater scheduling restrictions on seismic surveys and the protection of larger watershed estuarine areas used by marine mammals, including Cook Inlet beluga whales, as feeding areas. Though greater scheduling restrictions to seismic surveys would occur, four months would be available for G&G activities in the calendar year. The mitigations outlined in this alternative would protect most marine mammals in the vicinity of the Lease Area to a greater degree than other alternatives and greatly lower the likelihood of Level A or Level B Harassment from occurring to marine mammals, especially during summer when they feed near river mouths. The mitigations in Alternative 3C would not protect marine mammals from the effects of oil spills. The overall impact ratings for marine mammals would be: **minor** for routine activities, **negligible effect** for a small spill, and **moderate** for a large spill without any mitigations. With the standard suite of NMFS and USFWS mitigations there should be a negligible to minor level of effects to marine mammals from routine activities, negligible effect from small spills, and a negligible level of effects from large spills for all marine mammals other than sea otters. Sea otters would experience a moderate level of effects from a large spill due to the severe adverse effects oiling often has on the insulative integrity of their fur.

4.5.7. Terrestrial Mammals

Potential impacts on terrestrial mammals under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.7. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM’s review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on terrestrial mammals evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on terrestrial mammals would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on terrestrial mammals would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on terrestrial mammals would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for a small spill, and **minor** for a large spill.

4.5.8. Birds

Potential impacts on birds under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.8. The birds and habitats in the 10 blocks affected by Alternatives 3A and 3B are expected to be similar to those in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM’s review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on birds evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on birds would be essentially the same as those for Alternative 1 (Proposed Action): **moderate** for routine activities, **minor** for small spills, and **major** for large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on birds would be essentially the same as those for Alternative 1 (Proposed Action): **moderate** for routine activities, **minor** for small spills, and **major** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on birds would be essentially the same as those for Alternative 1 (Proposed Action): **moderate** for routine activities, **minor** for small spills, and **major** for large spill.

4.5.9. Coastal and Estuarine Habitats

Potential impacts on coastal and estuarine habitats under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.9. These alternatives would affect 10 blocks, which encompass only 2.68% of the proposed Lease Sale Area.

Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these changes would be expected to alter the likelihood or severity of effects on coastal and estuarine habitats identified for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on coastal and estuarine habitats would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill. Expected and typical mitigation for construction of the buried onshore gas and oil pipeline through wetlands and under Anadromous Fish Streams would reduce impacts for routine activities to **negligible**.

Conclusion for Alternative 3B: Impacts of Alternative 3B on coastal and estuarine habitats would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill. Expected and typical mitigation for construction of the buried onshore gas and oil pipeline through wetlands and under Anadromous Fish Streams would reduce impacts for routine activities to **negligible**.

Conclusion for Alternative 3C: Impacts of Alternative 3C on coastal and estuarine habitats would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill. Expected and typical mitigation for construction of the buried onshore gas and oil pipeline through wetlands and under Anadromous Fish Streams would reduce impacts for routine activities to **negligible**.

4.5.10. Economy and Population

Potential impacts on the economy and population under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.10. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would most likely benefit salmon species and subsistence, personal use, and commercial salmon fisheries, and indirectly benefit economy and population. However, none of these changes would be expected to alter the likelihood or severity of effects on the economy and population identified for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on the economy and population would be essentially the same as those for Alternative 1 (Proposed Action): **minor** and beneficial for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on the economy and population would be essentially the same as those for Alternative 1 (Proposed Action): **minor** and beneficial for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on the economy and population would be essentially the same as those for Alternative 1 (Proposed Action): **minor** and beneficial for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.5.11. Commercial Fishing

Potential impacts on commercial fishing under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.11. The 10 blocks affected by these alternatives are located in an area where commercial fishing occurs, including drift gillnetting. Excluding the blocks (Alternative 3A) would eliminate approximately 10% of the blocks north of Anchor Point, but is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would most likely benefit salmon species and commercial salmon fisheries. However, none of these factors would be expected to change the likelihood or severity of impacts on commercial fishing evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on commercial fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on commercial fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on commercial fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.5.12. Subsistence Harvest Patterns

Potential impacts on subsistence harvest patterns under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.12. The potential for subsistence harvesting in the 10 blocks affected by these alternatives is expected to be similar to that in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would benefit salmon species and subsistence and personal use salmon fisheries. However, none of these changes would be expected to alter the likelihood or severity of effects on subsistence harvest patterns identified for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on subsistence harvest patterns would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on subsistence harvest patterns would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on subsistence harvest patterns would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for large spills.

4.5.13. Sociocultural Systems

Potential impacts on sociocultural systems under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.13. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would benefit salmon species and subsistence and personal use salmon fisheries. However, none of these factors would be expected to change the likelihood or severity of impacts on sociocultural systems evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on sociocultural systems would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on sociocultural systems would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on sociocultural systems would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for large spills.

4.5.14. Public and Community Health

Potential impacts on public and community health under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.14. These alternatives would affect only 10 blocks totaling or 2.68% of the proposed Lease Sale Area. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario as described in Section 2.4. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would benefit salmon species and subsistence and personal use salmon fisheries. However, none of these factors would be expected to change the likelihood or severity of impacts on public and community health evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on public and community health would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on public and community health would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on public and community health would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for large spills.

4.5.15. Recreation, Tourism and Visual Resources

Potential impacts on recreation, tourism, and visual resources under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.15. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would most likely benefit salmon species and recreation and tourism sectors based on recreational salmon fishing. However, none of these changes would be expected to alter the likelihood or severity of effects on recreation and tourism identified for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on recreation and tourism and visual resources would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for recreation and tourism and **minor** for visual resources for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on recreation and tourism and visual resources would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for recreation and tourism and **minor** for visual resources for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on recreation and tourism and visual resources would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for recreation and tourism and **minor** for visual resources for small spills, and **moderate** for a large spill.

4.5.16. Sport Fishing

Potential impacts on sport fishing under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.16. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would most likely benefit salmon species and sport fisheries. However, none of these factors would be expected to change the likelihood or severity of impacts on sport fishing evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on sport fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on sport fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on sport fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.5.17. Archaeological and Historic Resources

Potential impacts on archaeological and historic resources under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.17. It is expected that most impacts of routine activities on historic and prehistoric resources would be avoided under any action alternative through the archaeological survey and assessment requirements specified under BOEM's July 13, 2015 update to guidelines concerning archaeological and historic resources. The total level of activity under the E&D Scenario, including seafloor-disturbing activities that could affect archaeological and historic resources is not expected to change under Alternatives 3A or 3B. Alternatives 3A and 3B would not be expected to change the likelihood or severity of impacts on archaeological and historic resources evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on archaeological and historic resources would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **minor** for small spills, and **moderate** for large spills.

Conclusion for Alternative 3B: Impacts of Alternative 3B on archaeological and historic resources would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **minor** for small spills, and **moderate** for large spills.

Conclusion for Alternative 3C: Impacts of Alternative 3C on archaeological and historic resources would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **minor** for small spills, and **moderate** for large spills.

4.5.18. Areas of Special Concern

Potential impacts on Areas of Special Concern under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.18. Ten blocks affected by this alternative are not within or adjacent to Areas of Special Concern. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would most likely benefit salmon species and protected areas and other areas of special concern. The most important impacts on Areas of Special Concern are those resulting from accidental oil spills, the frequency of which is not change under Alternative 3A or 3B. Therefore, Alternatives 3A or 3B are not expected to change the likelihood or severity of impacts on Areas of Special Concern as evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on Areas of Special Concern would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **major** for large spills.

Conclusion for Alternative 3B: Impacts of Alternative 3B on Areas of Special Concern would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **major** for large spills.

Conclusion for Alternative 3C: Impacts of Alternative 3C on Areas of Special Concern would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **major** for large spills.

4.5.19. Oil and Gas and Related Infrastructure

Potential impacts on oil and gas infrastructure under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.19. The 10 blocks affected by these alternatives are not known to include any subsea pipelines or cables. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would most likely have negligible effects on existing oil and gas infrastructure. However, none of these factors would be expected to change the likelihood or severity of impacts on subsea cables or other oil and gas infrastructure evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on oil and gas and related infrastructure would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for large spills.

Conclusion for Alternative 3B: Impacts of Alternative 3B on oil and gas and related infrastructure would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for large spills.

Conclusion for Alternative 3C: Impacts of Alternative 3C on oil and gas and related infrastructure would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for large spills.

4.5.20. Environmental Justice

Potential impacts on environmental justice communities under Alternatives 3A or 3B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.20. Excluding the blocks (Alternative 3A) is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 3B) could change the timing of seismic survey and exploration activities and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would eliminate or decrease impacts of proposed seismic sounds for a large part of the year. This would benefit salmon species and subsistence and personal use salmon fisheries. However, none of these factors would be expected to change the likelihood or severity of impacts on environmental justice communities evaluated for Alternative 1.

Conclusion for Alternative 3A: Impacts of Alternative 3A on environmental justice communities would be essentially the same as those for Alternative 1 (Proposed Action): disproportionately high and adverse for a large spill.

Conclusion for Alternative 3B: Impacts of Alternative 3B on environmental justice communities would be essentially the same as those for Alternative 1 (Proposed Action): disproportionately high and adverse for a large spill.

Conclusion for Alternative 3C: Impacts of Alternative 3C on environmental justice communities would be essentially the same as those for Alternative 1 (Proposed Action): disproportionately high and adverse for a large spill.

4.6. Alternatives 4A and 4B – Northern Sea Otter Critical Habitat Exclusion or Mitigation

Alternative 4A would exclude 7 OCS blocks from the proposed Lease Sale Area that overlap with critical habitat for the northern sea otter, resulting in 217 OCS blocks offered for lease. Alternative 4B would require additional mitigation in 7 OCS blocks that overlap with critical habitat for the northern sea otter, resulting in 224 OCS blocks offered for lease (Figure 2.2.4-1). There are 6 OCS blocks overlapping with the northern sea otter critical habitat along the western edge of the proposed Lease Sale Area (OPD NO05-02, Blocks 6055, 6056, 6057, 6105, 6106, and 6155). One additional block in the north-central portion of the proposed Lease Sale Area (OPD NP05-08, Block 6911) also contains a small area of critical habitat (Figure 2.2.4-1). The areal extent of the sea otter critical habitat is 11,893 ha (29,388 ac), or 2.69% of the proposed Lease Sale Area. The critical habitat occurring within the excluded OCS blocks represents approximately 0.23% of the total area of the northern sea otter critical habitat. Detailed descriptions of Alternatives 4A and 4B are presented in Section 2.2.4. Potential impacts of Alternatives 4A and 4B, by resource, are described in the subsections below.

4.6.1. Air Quality

Potential impacts on air quality under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.1. Air quality in the seven blocks affected by these alternatives is expected to be similar to that in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D

Scenario. The geographic exclusion would not prevent emissions sources from being built in the proximity of sensitive Class I areas such as the Tuxedni National Wilderness Area, which could still be affected by emissions sources in the alternative lease area. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM’s review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on air quality evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on air quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **minor** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on air quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **minor** for a large spill.

4.6.2. Water Quality

Potential impacts on water quality under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.2. Water quality in the seven blocks affected by these alternatives is expected to be similar to that in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM’s review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on water quality evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on water quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on water quality would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.6.3. Acoustic Environments

Potential impacts on acoustic environments under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.3. The acoustic environment in the seven blocks affected by these alternatives is expected to be similar to that in the rest of the proposed Lease Sale Area. Impacts to the acoustic environment are the result of sound propagation through the water based on the level of development activity which is not expected to change with these Alternatives. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM’s review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on acoustic environments evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on acoustic environments would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on acoustic environments would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.6.4. Lower Trophic Level Organisms

Potential impacts on lower trophic level organisms under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.4. Water column and benthic communities in the seven blocks affected by these alternatives are expected to be similar to those in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on lower trophic level organisms evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on lower trophic level organisms would remain unchanged from the Proposed Action (Alternative 1): **minor** for routine activities, **minor** for small spills, and **moderate** for large spills.

Conclusion for Alternative 4B: Impacts of Alternative 4B on lower trophic level organisms would remain unchanged from the Proposed Action (Alternative 1): **minor** for routine activities, **minor** for small spills, and **moderate** for large spills.

4.6.5. Fish and Shellfish

Potential impacts on fish and shellfish under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.5. These alternatives would affect only seven lease blocks, which encompass only 2.69% of the proposed Lease Sale Area. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on fish and shellfish evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on fish and shellfish would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on fish and shellfish would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.6.6. Marine Mammals

Alternatives 4A and 4B focus specifically on northern sea otter critical habitat, and marine mammals are the only resource for which impacts are expected to differ markedly from those of the Proposed Action (Alternative 1) in Section 4.3.6. These alternatives would affect seven lease blocks, which encompass only 2.69% of the proposed Lease Sale Area. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Mitigation (Alternative 4B) would prohibit drilling discharges and seafloor-disturbing activities in water depths <20 m (66 ft) in those blocks and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs.

The areal extent of the sea otter critical habitat blocks is 11,893 ha (29,388 ac), representing approximately 0.23% of the total area of the northern sea otter critical habitat. Northern sea otters are found in low densities throughout the year in lower Cook Inlet and are not migratory. The designated critical habitat ranges from the end of the Aleutian Islands to lower western Cook Inlet, and includes the Kodiak Archipelago. In Cook Inlet, the critical habitat extends northward along the western shoreline to Redoubt Point, and from the mean high tide line to the 20-m (66-ft) depth contour. The information developed by the USFWS in support of the critical habitat designation and recovery plan for the northern sea otter does not indicate the presence of any unique features in the lease blocks that are within the proposed Lease Sale Area or otherwise differentiate them from the remainder of the critical habitat.

Under Alternative 4A, the sea otter critical habitat blocks would be excluded from the proposed Lease Sale Area. The exclusion would reduce the potential for interactions between sea otters and OCS oil and gas activities in those blocks. The exclusion would eliminate drilling discharges and seafloor-disturbing activities as impact sources in specific areas identified as critical habitat for sea otters. Sources of underwater noise and disturbance, including on-lease seismic surveys, construction activities, vessels, and drilling and production operations, would be eliminated from the blocks. Sea otters (and other marine mammals) could be exposed to noise from activities in adjacent blocks, but at greater distances from the sources. Exclusion of the sea otter critical habitat blocks would not meaningfully change the risk or severity of impacts on sea otters or any other marine mammals occurring in the remainder of the proposed Lease Sale Area.

Habitat loss was ranked as “low importance” in the Southwest Alaska DPS of northern sea otter recovery plan (USFWS, 2013a). Since only a small portion of the proposed Lease Sale Area occurs (representing 0.23% of the proposed Lease Sale Area) within the approximately 15,280 km^2 (5,900 mi^2) (Lance, 2013) of the Southwest Alaska DPS of sea otter critical habitat, seafloor disturbance from the Proposed Action should have a minor level of effects on the foraging opportunities within the species range. No alteration to sea otter critical habitat would result from the Proposed Action, though platform placement and drilling could produce temporary adverse effects to a small amount of critical habitat. Conversely, the protections from impacts stemming from habitat loss/seafloor disturbance offered under Alternative 4A, would be beneficial, but small.

Prey base was given a “low importance” ranking in the Southwest Alaska DPS of northern sea otter recovery plan (USFWS, 2013a). Drilling discharges that reach the seafloor could reduce sea otter benthic prey availability around the footprint of the well. Because of their small size, elevated metabolic rate, and limited capacity for storing energy reserves, sea otters must maintain a consistently high rate of food intake (Costa and Kooyman, 1982); consequently, they are vulnerable to even small fluctuations in prey abundance (USFWS, 2013a). Alternative 4A would provide some protection to sea otter’s prey base as well drilling and the accompanying drilling discharges would be prevented from occurring in critical habitat.

Although disturbance was ranked as “low importance” in the Southwest Alaska DPS of northern sea otter recovery plan (USFWS, 2013a), reducing or eliminating vessel traffic (and the subsequent impacts) in sea otter critical habitat is perhaps the most significant protection provided under Alternative 4A. Because sea otters are slow swimmers relative to other marine mammals and spend much of their time at the surface resting, grooming, and nursing their young, they would appear to be highly vulnerable to disturbance by boats (USFWS, 2013a). Garshelis and Garshelis (1984) reported that when there was heavy vessel traffic in Orca Inlet, Alaska, from May through September from the commercial fishing fleet, the numbers of male sea otters were less than those seen in the same area during winter months when vessel traffic was light. They believed that seasonal changes in disturbances from vessels were largely responsible for seasonal movements among the male areas, and that vessel traffic also deterred sea otters from using the regions between the various male areas (Garshelis and Garshelis, 1984). Additionally, boat traffic could disturb resting patterns of sea otters. Sea otters in Alaska haul out regularly and when they do, they will often move into the water with the approach of a boat (USDOI, MMS, 2003). Garrott, Eberhardt, and Burn (1993) reported that sea otters on shore would move into the water with approach of a single small motorboat moving parallel to and 100 m (328 ft) from shore. Alternative 4A would not prohibit support vessels or helicopters from transiting through the deferred blocks.

Oil spills are listed as a "low to moderate importance" in the Southwest Alaska DPS of northern sea otter recovery plan (USFWS, 2013a), and were described as having potentially severe impacts to sea otters from large spills associated with the potential action under Alternative 1. Exclusion of the blocks would not change the overall level of activity under the E&D Scenario, and therefore would not change the risk of accidental spills. Alternative 4A is will not prevent the adverse effects of a large spill to sea otters exposed to oil. A mitigation alternative (Alternative 4B) was also developed based on an analysis conducted using the PCEs deemed essential to the conservation of the northern sea otter as identified in the critical habitat designation (Table 2.2.4-1). Under Alternative 4B, the sea otter critical habitat would be included in Lease Sale 244, but lessees would be prohibited from discharging drilling fluids and cuttings, and conducting seafloor-disturbing activities (including anchoring and placement of bottom-founded structures) within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat. Lessees may request a waiver from or variance to this stipulation at the time of filing an EP by providing the method, and an analysis evaluating the method, of protecting the northern sea otter critical habitat from the specified activities in the EP.

Prohibition of drilling discharges and seafloor-disturbing activities within critical habitat would reduce the potential for impacts on sea otters due to alteration of their benthic habitats. However, other impacts would remain unchanged. Sea otters could be disturbed by underwater noise from seismic surveys, vessels, and drilling activities. Support vessels and helicopters may pass through the blocks. The mitigation in this alternative would not change the risks or impacts of accidental spills. Finally, the mitigation would not meaningfully change the risk or severity of impacts on sea otters or other marine mammals occurring in the remainder of the proposed Lease Sale Area. Alternative 4B would not provide any additional protection to sea otters (or other marine mammals) from large spills.

Conclusion for Alternative 4A: Alternative 4A would slightly reduce the risk of impacts on sea otters relative to Alternative 1 (Proposed Action). Exclusion of northern sea otter critical habitat area would eliminate the possibility of permanent structures (such as a production platform) that could adversely affect northern sea otter habitat (e.g., for foraging) and reduce vessel traffic that would be expected to transit through the northern sea otter critical habitat area. Alternative 4A is evaluated as slightly more effective than Alternative 4B in reducing impacts to sea otter critical habitat due to a significant decrease in vessel traffic and other activities that would occur as a result of block exclusion under Alternative 4A. The overall impact ratings for marine mammals remain unchanged: **negligible** for routine activities, **negligible effect** for small spills, and **negligible** for a large spill.

Conclusion for Alternative 4B: Alternative 4B would slightly reduce the risk of impacts on sea otters relative to Alternative 1 (Proposed Action). The mitigation in Alternative 4B focuses on reducing benthic habitat impacts near drilling and production sites in water depths <20 m (66 ft). Alternative 4B is evaluated as slightly less effective than Alternative 4A in reducing impacts to sea otter critical habitat due to a higher level of vessel traffic that would occur in the critical habitat area. The overall impact ratings for marine mammals remain unchanged: **negligible** for routine activities, **negligible effect** for small spills, and **negligible** for a large spill.

4.6.7. Terrestrial Mammals

Potential impacts on terrestrial mammals under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.7. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on terrestrial mammals evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on terrestrial mammals would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on terrestrial mammals would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.6.8. Birds

Potential impacts on birds under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.8. The birds and habitats in the seven blocks affected by these alternatives are similar to those in the rest of the proposed Lease Sale Area. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on birds evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on birds would remain unchanged from the Proposed Action (Alternative 1): **moderate** for routine activities, **minor** for small spills, and **major** for accidental spills.

Conclusion for Alternative 4B: Impacts of Alternative 4B on birds would remain unchanged from the Proposed Action (Alternative 1): **minor** for routine activities, **minor** for small spills, and **major** for accidental spills.

4.6.9. Coastal and Estuarine Habitats

Potential impacts on coastal and estuarine habitats under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.9. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on coastal and estuarine habitats evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on coastal and estuarine habitats would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill. Expected and typical mitigation for construction of the buried onshore gas and oil pipeline through wetlands and under Anadromous Fish Streams would reduce impacts for routine activities to **negligible**.

Conclusion for Alternative 4B: Impacts of Alternative 4B on coastal and estuarine habitats would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill. Expected and typical mitigation for construction of the buried onshore gas and oil pipeline through wetlands and under Anadromous Fish Streams would reduce impacts for routine activities to **negligible**.

4.6.10. Economy and Population

Potential impacts on the economy and population under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.10. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on the economy and population evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on the economy and population would be essentially the same as those for Alternative 1 (Proposed Action): **minor** and beneficial for routine activities, **negligible** for small spills, and **minor** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on the economy and population would be essentially the same as those for Alternative 1 (Proposed Action **minor** and beneficial for routine activities, **negligible** for small spills, and **minor** for a large spill

4.6.11. Commercial Fishing

Potential impacts on commercial fishing under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.11. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on commercial fishing evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on commercial fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on commercial fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.6.12. Subsistence Harvest Patterns

Potential effects on subsistence harvest patterns under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.12. Excluding of the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on subsistence harvest patterns evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on subsistence harvest patterns would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on subsistence harvest patterns would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

4.6.13. Sociocultural Systems

Potential impacts on sociocultural systems under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.13. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m

(3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on sociocultural systems evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on sociocultural systems would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on sociocultural systems would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

4.6.14. Public and Community Health

Potential impacts on public and community health under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.14. These alternatives would affect only seven lease blocks, or 2.69% of the proposed Lease Sale Area. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on public and community health evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on public and community health would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on public and community health would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.6.15. Recreation, Tourism, and Visual Resources

Potential effects on recreation, tourism, and visual resources under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.15. Deferral of the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on recreation and tourism and visual resources evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on recreation and tourism and visual resources would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for recreation and tourism and **minor** for visual resources for small spills, and **moderate** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on recreation and tourism and visual resources would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for recreation and tourism and **minor** for visual resources for small spills, and **moderate** for a large spill.

4.6.16. Sport Fishing

Potential impacts on sport fishing under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.16. Deferral of the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on sport fishing evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on sport fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on sport fishing would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.6.17. Archaeological and Historic Resources

Potential impacts on archaeological and historic resources under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.17. It is expected that most impacts of routine activities on archaeological and historic resources would be avoided under any action alternative through the archaeological survey and assessment requirements specified under BOEM's July 13, 2015 update to guidelines concerning archaeological and historic resources. Deferral or changes in timing of seismic surveys or exploration drilling would not change the total level of activity under the E&D Scenario, including seafloor-disturbing activities that could affect archaeological and historic resources. Alternatives 4A and 4B would not be expected to change the likelihood or severity of impacts on archaeological and historic resources evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on archaeological and historic resources would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **minor** for small spills, and **moderate** for large spills.

Conclusion for Alternative 4B: Impacts of Alternative 4B on archaeological and historic resources would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **minor** for small spills, and **moderate** for large spills.

4.6.18. Areas of Special Concern

Potential impacts on Areas of Special Concern under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.18. The seven blocks affected by this alternative are offshore of Lake Clark NPP, which is an Area of Special Concern. However, routine activities are not expected to have significant impacts on the Lake Clark NPP. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on Areas of Special Concern evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on Areas of Special Concern would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **major** for large spills.

Conclusion for Alternative 4B: Impacts of Alternative 4B on Areas of Special Concern would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **major** for large spills.

4.6.19. Oil and Gas and Related Infrastructure

Potential impacts on oil and gas and related infrastructure under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.19. The seven lease blocks affected by these alternatives are not known to include any subsea pipelines or cables. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on subsea cables or other oil and gas infrastructure evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 4A on oil and gas and related infrastructure would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for large spills.

Conclusion for Alternative 4B: Impacts of Alternative 4B on oil and gas and related infrastructure would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for large spills.

4.6.20. Environmental Justice

Potential impacts on environmental justice communities under Alternatives 4A or 4B would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.20. Excluding the blocks (Alternative 4A) is not expected to change the total level of activity under the E&D Scenario. Alternative 4B would prohibit drilling discharges and seafloor-disturbing activities within 1,000 m (3,281 ft) of areas designated as northern sea otter critical habitat and may involve additional restrictions on activities based on BOEM's review of EPs and DPPs. However, none of these factors would be expected to change the likelihood or severity of impacts on environmental justice communities evaluated for Alternative 1.

Conclusion for Alternative 4A: Impacts of Alternative 3A on environmental justice communities would be essentially the same as those for Alternative 1 (Proposed Action): disproportionately high and adverse for a large spill.

Conclusion for Alternative 4B: Impacts of Alternative 4B on environmental justice communities would be essentially the same as those for Alternative 1 (Proposed Action): disproportionately high and adverse for a large spill.

4.7. Alternative 5 – Gillnet Fishery Landscape Mitigation Area

Under Alternative 5, 22 OCS blocks would be offered for lease, but all OCS blocks north of Anchor Point would be identified as an LMA with additional mitigation to reduce the potential for conflicts with the Cook Inlet drift gillnet fishery. This alternative would affect 117 OCS blocks with an area of 203,932 ha (503,928 ac), or 46.05% of the proposed Lease Sale Area (Figure 2.2.5-1). A detailed description of Alternative 5 is presented in Section 2.2.5. Potential impacts of Alternative 5, by resource, are described in the subsections below.

4.7.1. Air Quality

Potential impacts on air quality under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.1. Alternative 5 would not prevent emissions sources from being built in the proximity of sensitive Class I areas such as the Tuxedni National Wilderness Area. Depending on the schedule of seismic surveys and exploration drilling, the time-of-year exclusions in Alternative 5 could increase emissions during the rest of the year that would otherwise have been more spread throughout the gillnetting season. The weekday restrictions on support vessel trips would reduce vessel emissions in Cook Inlet, but may result in a higher number of helicopter flights, or increased vessel activity on the other days of the week.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on air quality would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **minor** for a large spill.

4.7.2. Water Quality

Potential impacts on water quality under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.2. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including discharges or other factors affecting water quality. This Alternative would not be expected to change the likelihood or severity of impacts on water quality evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on water quality would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.7.3. Acoustic Environments

Potential impacts on acoustic environments under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.3. Impacts to the acoustic environment are the result of sound propagation through the water based on the level of development activity, which is not expected to change with this Alternative. The impact to the soundscape will remain with the levels and extent described in Section 4.3.3, and none of these factors would be expected to change the likelihood or severity of impacts on acoustic environments evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on acoustic environments would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.7.4. Lower Trophic Level Organisms

Potential impacts on lower trophic level organisms under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.4. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including discharges or other factors affecting lower trophic level organisms. This Alternative would not be expected to change the likelihood or severity of impacts on lower trophic level organisms evaluated for Alternative 1.

Conclusion for Alternative 5: Impacts of Alternative 5 on lower trophic level organisms would remain unchanged from the Proposed Action (Alternative 1): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.7.5. Fish and Shellfish

Potential impacts on fish and shellfish under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.5. Alternative 5 would restrict timing of on-lease seismic activities during the drift gillnet fishing season and increase planned coordination between the oil and gas industry and the drift gillnet fishing industry. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including discharges or other factors affecting fish and shellfish. This alternative would not be expected to change the likelihood or severity of impacts on fish and shellfish evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on fish and shellfish would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.7.6. Marine Mammals

Potential impacts on marine mammals under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.6. The additional mitigation measures would not change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 5) could change the timing of seismic survey activities. Accordingly, impacts on marine mammals from active acoustic sound sources would be reduced overall due to the restriction of seismic operations during important summer feeding and rearing times. Alternative 5 would not reduce the potential impacts to marine mammals in the event of an oil spill and would not be expected to change the likelihood or severity of impacts on marine mammals evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on marine mammals would be the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible effect** for small spills, and **negligible** for a large spill.

4.7.7. Terrestrial Mammals

Potential impacts on terrestrial mammals under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.7. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including onshore activities potentially affecting terrestrial mammals. This Alternative would not be expected to change the likelihood or severity of impacts on terrestrial mammals evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on terrestrial mammals would be the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.7.8. Birds

Potential impacts on birds under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.8. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including factors affecting birds. This Alternative would not be expected to change the likelihood or severity of impacts on birds evaluated for Alternative 1.

Conclusion for Alternative 5: Impacts of Alternative 5 on birds would remain unchanged from the Proposed Action (Alternative 1): **moderate** for routine activities, **minor** for small spills, and **major** for large spills.

4.7.9. Coastal and Estuarine Habitats

Potential impacts on coastal and estuarine habitats under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.9. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including factors affecting coastal and estuarine habitats. This Alternative would not be expected to change the likelihood or severity of impacts on coastal and estuarine habitats evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on coastal and estuarine habitats would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill. Expected and typical mitigation for construction of the buried onshore gas and oil pipeline through wetlands and under Anadromous Fish Streams would reduce impacts for routine activities to **negligible**.

4.7.10. Economy and Population

Potential impacts on the economy and population under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.10. The additional mitigation measures would not change the total level of activity under the E&D Scenario, and therefore would not change the economic consequences including direct and indirect employment, taxes, and royalties. This Alternative would not be expected to change the likelihood or severity of impacts on the economy and population evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on economy and population would be the same as those for Alternative 1 (Proposed Action): **minor** and beneficial for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.7.11. Commercial Fishing

Under Alternative 5, lessees will not conduct on-lease seismic surveys during drift gillnetting season as designated by the ADFG. With the implementation of this mitigation measure, it is expected that routine operations, including physical presence and vessel traffic, would result in negligible effects on the commercial drift gillnet fishery. Seismic surveys would occur outside the drift gillnet fishing season, while changes in frequency of occurrence of exploration and development vessel traffic would be coordinated with local gillnet fishers. However, temporary displacement of fishery resources from localized areas could occur as a consequence of noise and activities associated with construction activities during development. These resources would be expected to return once construction disturbances have been terminated. Following platform construction, there could be some highly localized long-term changes in fish densities and species diversity in the vicinity of platforms due to attraction of some invertebrate and fish species. The physical presence of production platforms near specific riptide locations could have a minor impact on the drift gillnet fishing industry.

Conclusion for Alternative 5: While Alternative 5 would essentially eliminate impacts to drift gillnet commercial fishing from on-lease seismic surveys, other routine operations would be expected to cause localized and short-term effects to the overall commercial fishery under the Proposed Action (Alternative 1). The overall effects of routine activities on commercial fishing, including drift gillnet fishing, are not expected to be different than those under the Proposed Action. Because the mitigation included in Alternative 5 would not change the overall level of activity under the E&D Scenario, there would be no change in the risk or impacts of accidental spills. The impact ratings would remain the same as those for Alternative 1: **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.7.12. Subsistence Harvest Patterns

Potential impacts on subsistence harvest patterns under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.12. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including activities potentially affecting subsistence harvest patterns. This Alternative would not be expected to change the likelihood or severity of impacts on subsistence harvest patterns evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on subsistence harvest patterns would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

4.7.13. Sociocultural Systems

Potential impacts on sociocultural systems under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.13. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including activities potentially affecting sociocultural systems. This Alternative would not be expected to change the likelihood or severity of impacts on sociocultural systems evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on sociocultural systems would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

4.7.14. Public and Community Health

Potential impacts on public and community health under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.14. This alternative would affect 117 lease blocks, or 46.05% of the proposed Lease Sale Area. Application of the mitigation measures is not expected to change the total level of activity under the E&D Scenario. Requiring additional mitigation in the blocks (Alternative 5) could change the timing of seismic survey activities. However, none of these factors would be expected to change the likelihood or severity of impacts on public and community health evaluated for Alternative 1.

Conclusion for Alternative 5: Impacts of Alternative 5 on public and community health would be essentially the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.7.15. Recreation, Tourism, and Visual Resources

Potential impacts on recreation, tourism, and visual resources under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.15. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including activities potentially affecting recreation, tourism, and visual resources such as the physical presence of offshore structures and lights, increased vessel traffic, and accidental spills. This Alternative would not be expected to change the likelihood or severity of impacts on recreation, tourism, and visual resources evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on sport fishing would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for recreation and tourism and **minor** for visual resources for small spills, and **moderate** for a large spill.

4.7.16. Sport Fishing

Potential impacts on sport fishing under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.16. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including activities potentially affecting sport fishing such as exclusion zones around exploration and development sites, increased vessel traffic, and accidental spills. This Alternative would not be expected to change the likelihood or severity of impacts on sport fishing evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on recreation, tourism, and visual resources would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.7.17. Archaeological and Historic Resources

Potential impacts to archaeological and historic resources under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 3.3.2.17. It is expected that most impacts of routine activities on historic and prehistoric resources would be avoided through the archaeological survey and assessment requirements specified under BOEM’s July 13, 2015 update to guidelines concerning archaeological and historic resources. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including seafloor-disturbing activities that could affect archaeological resources. This Alternative would not be expected to change the likelihood or severity of impacts on archaeological resources evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on archaeological resources would be the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **minor** for small spills, and **moderate** for large spills.

4.7.18. Areas of Special Concern

Potential impacts on Areas of Special Concern under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.18. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including activities potentially affecting Areas of Special Concern such as accidental oil spills. This Alternative would not be expected to change the likelihood or severity of impacts on Areas of Special Concern evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on Areas of Special Concern would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **major** for accidental spills.

4.7.19. Oil and Gas and Related Infrastructure

Potential impacts on the oil and gas and related infrastructure under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.19. It is expected that most impacts of routine activities on submerged infrastructure such as pipelines and cables would be avoided through the geohazard survey requirements specified in NTLs 2005-A01 and 2005-A02. The additional mitigation measures would not change the total level of activity under the E&D Scenario, including activities potentially affecting oil and gas infrastructure and submarine cables. This Alternative would not be expected to change the likelihood or severity of impacts evaluated for Alternative 1.

Conclusion for Alternative 5: Impacts of Alternative 5 on oil and gas and related infrastructure would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for large spills.

4.7.20. Environmental Justice

Potential impacts on environmental justice communities under Alternative 5 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.20. The additional mitigation measures would not change the total level of activity under the E&D Scenario, which is not expected to have disproportionate adverse impacts on low-income and minority populations. This Alternative would not be expected to change the likelihood or severity of impacts evaluated for Alternative 1.

Conclusion for Alternative 5: Ratings for the impacts of Alternative 5 on environmental justice communities would be the same as those for Alternative 1 (Proposed Action): disproportionately high and adverse for a large spill.

4.8. Alternative 6 – Prohibition of Drilling Discharges

Alternative 6 would offer the same 224 OCS blocks as Alternative 1 (Proposed Action) but would prohibit the discharge of all drilling fluids and cuttings. As discussed in Section 2.4, BOEM estimates that 7 to 10 exploration wells will be drilled in the proposed Lease Sale Area, with each well generating approximately 435 tons of WBFs and 747 tons of cuttings. Under Alternative 1, drilling fluids and cuttings from exploration wells would be discharged at the wellsite, but under Alternative 6 they would be transported to shore for land-based disposal. A detailed description of Alternative 6 is presented in Section 2.2.6. Potential impacts of Alternative 6, by resource, are described in the subsections below.

4.8.1. Air Quality

Potential impacts on air quality under Alternative 6 would differ slightly from those described for the Proposed Action (Alternative 1) in Section 4.3.1. Alternative 6 would likely result in slightly increased air pollutant emissions during the exploration phase as compared to Alternative 1 due to additional barge trips that would be necessary to transport drilling fluids and cuttings to shore for the 7 to 10 exploration wells. Based on the estimated drilling fluid and cuttings weights to be transported to shore, the number of barge trips would increase by approximately 14%. The estimated 102 additional trips would result in additional air pollutant emissions during the exploration phase (year 2 through year 5). Ground transportation of the additional drilling fluids and cuttings to their final disposal sites would likely result in additional air pollutant emissions beyond was estimated for Alternative 1. The additional emissions would represent a small percentage of the emissions from all sources during exploration (e.g., from drilling rigs, support vessels, and helicopters) and would not substantially change the severity or extent of air pollutant impacts from all sources during exploration. The air quality impacts of development and production activities would be the same as for the Proposed Action.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on air quality would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **minor** for a large spill.

4.8.2. Water Quality

Potential impacts on water quality under Alternative 6 would differ slightly from those described for the Proposed Action (Alternative 1) in Section 4.3.2. Under Alternative 6, all impacts of drilling discharges on water quality described for the Proposed Action would be eliminated. These impacts consist of turbidity caused by discharge plumes as they are dispersed in the water column, typically within a few kilometers down current from a drillsite. In Cook Inlet, it is expected that drilling fluids and cuttings discharges would be quickly transported away by strong currents. In addition, all sediment quality impacts resulting from deposition (if any) of drilling fluids and cuttings on the seafloor around the exploration sites would be avoided. These consist mainly of changes in grain size, mineralogy, redox conditions, and concentrations of barium (and perhaps other metals). The water quality impacts that would be avoided occur intermittently throughout the time it takes to drill a well (estimated to be 30 to 60 days). The sediment quality impacts that would be avoided may persist for months to years.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on water quality would be **negligible** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.8.3. Acoustic Environments

Potential impacts on acoustic environments under Alternative 6 would differ slightly from those described for the Proposed Action (Alternative 1) in Section 4.3.3. This alternative would result in a slight increase in underwater vessel noise due to additional barge trips necessary to transport drilling fluids and cuttings to shore. Based on the estimated drilling fluid and cuttings weights to be transported to shore, the number of barge trips would increase by approximately 14%. The estimated 102 additional trips would result in additional underwater noise during the exploration phase (year 2 through year 5). When considered in relation to the overall existing acoustic environment in Cook Inlet and the estimated impacts to the acoustic environment associated with the Proposed Action, the increased vessel noise associated with Alternative 6 would not be expected to change the likelihood or severity of impacts on the acoustic environment evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on acoustic environments would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.8.4. Lower Trophic Level Organisms

Potential impacts on lower trophic level organisms under Alternative 6 would differ slightly from those described for the Proposed Action (Alternative 1) in Section 4.3.4. Under Alternative 6, all impacts of drilling discharges on lower trophic level organisms described for the Proposed Action would be eliminated. Little or no impact on water column organisms (e.g., plankton) is expected under the Proposed Action because drilling fluids and cuttings are expected to be quickly dispersed by strong currents, and plankton would not be exposed to these discharges long enough and at sufficiently high concentrations to elicit any acute or sublethal responses. The analysis of the Proposed Action assumes that drilling discharges may accumulate on the seafloor, but it is expected that drilling fluids and cuttings discharges would be quickly transported away by strong currents and adverse benthic impacts such as burial and smothering will not be detected. These benthic community impacts, which are not expected to persist at each exploration wellsite, would be avoided under Alternative 6.

Conclusion for Alternative 6: Impacts of Alternative 6 on lower trophic level organisms would remain unchanged from the Proposed Action (Alternative 1): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.8.5. Fish and Shellfish

Potential impacts on fish and shellfish under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.5. Under Alternative 6, all impacts of drilling discharges on fish and shellfish described for the Proposed Action would be eliminated. Little or no impact on pelagic fishes is expected under the Proposed Action because drilling fluids and cuttings are expected to be quickly dispersed by strong currents, and fishes would not be exposed to these discharges long enough and at sufficiently high concentrations to elicit any acute or sublethal responses. The analysis for the Proposed Action assumes that drilling discharges may accumulate on the seafloor, but it is expected that they would be quickly transported away by strong currents and adverse impacts to benthic habitat for demersal fishes would be not be detected. These impacts on demersal fish habitat, which are not expected to persist at each exploration wellsite, would be avoided under Alternative 6.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on fish and shellfish would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.8.6. Marine Mammals

Potential impacts on marine mammals under Alternative 6 would differ slightly from those described for the Proposed Action (Alternative 1) in Section 4.3.6. Vessel traffic is a source of disturbance to marine mammals and vessel strikes can kill or injure marine mammals. Alternative 6 would increase the number of barge trips by 14% during the exploration phase (year 2 through year 5). The estimated additional 102 trips would represent a small percentage of the total vessel trips during exploration and would not substantially increase the risk of vessel strikes or disturbance by vessel noise. Most severe and lethal whale injuries are caused by vessels moving at relatively high speed, whereas the barges transporting cuttings are expected to move slowly and allow time for marine mammals to avoid them. Levels of vessel traffic during development and production would be the same as for the Proposed Action.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on marine mammals would be the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible effect** for small spills, and **negligible** for a large spill.

4.8.7. Terrestrial Mammals

Potential impacts on terrestrial mammals under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.7. There would be additional truck traffic to transport cuttings from the shore base to a disposal facility. However, the additional trips would represent a small percentage of the total traffic in the region would not substantially increase the risk of disturbing or striking terrestrial mammals along area roadways. There would be no change in other relevant IPFs for terrestrial mammals, and Alternative 6 would not change the estimated size or frequency of accidental spills.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on terrestrial mammals would be the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.8.8. Birds

Potential impacts on lower trophic level organisms under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.8. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Disruption of benthic food sources from drilling discharges is expected to be localized and temporary under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on birds as evaluated for Alternative 1.

Conclusion for Alternative 6: Impacts of Alternative 6 on birds would remain unchanged from the Proposed Action (Alternative 1): **moderate** for routine activities, **minor** for small spills, and **major** for a large spill.

4.8.9. Coastal and Estuarine Habitats

Potential impacts on coastal and estuarine habitats under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.9. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for coastal and estuarine habitats under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on coastal and estuarine habitats as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on coastal and estuarine habitats would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill. Expected and typical mitigation for construction of the buried onshore gas and oil pipeline through wetlands and under Anadromous Fish Streams would reduce impacts for routine activities to **negligible**.

4.8.10. Economy and Population

Potential impacts on the economy and population under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.10. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for economy and population under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills.

As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on the economy and population as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on economy and population would be the same as those for Alternative 1 (Proposed Action): **minor** and beneficial for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.8.11. Commercial Fishing

Potential impacts on commercial fishing under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.11. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for commercial fishing under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on the commercial fishing as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on commercial fishing would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.8.12. Subsistence Harvest Patterns

Potential impacts on subsistence harvest patterns under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.12. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges are expected to cause short-term and localized and thus minor impacts to subsistence harvest patterns under the Proposed Action, so the elimination of drilling discharges would change the impact analysis for drilling discharges from minor to negligible. Alternative 6 would have no impact on the estimated size or frequency of accidental spills. Given the other IPFs potentially affecting subsistence harvest patterns under the Proposed Action and the relatively small geographic area that would be subject to drilling discharges, Alternative 6 would not be expected to change the overall likelihood or severity of impacts on subsistence harvest patterns as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on subsistence harvest patterns would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

4.8.13. Sociocultural Systems

Potential impacts on sociocultural systems under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.13. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for sociocultural systems under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on the commercial fishing as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on sociocultural systems would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **major** for a large spill.

4.8.14. Public and Community Health

Potential impacts on public and community health under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.14. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for public and community health under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on the public and community health as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on public and community health would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.8.15. Recreation, Tourism, and Visual Resources

Potential impacts on recreation, tourism, and visual resources under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.15. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for recreation, tourism, and visual resources under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on recreation, tourism, and visual resources as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on recreation, tourism, and visual resources would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for recreation and tourism and **minor** for visual resources for small spills, and **moderate** for a large spill.

4.8.16. Sport Fishing

Potential impacts on sport fishing under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.16. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for sport fishing under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on the sport fishing resources as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on sport fishing would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.8.17. Archaeological and Historic Resources

Potential impacts on archaeological and historic resources under Alternative 6 would differ slightly from those described for the Proposed Action (Alternative 1) in Section 4.3.17. Under Alternative 6, any impacts from drilling discharges on submerged archaeological resources, such as burial, would not occur. Pre-drilling geohazard surveys specified under BOEM's July 13, 2015 update to guidelines concerning archaeological and historic resources are expected to identify existing submerged archaeological resources prior to drilling activities and preclude most impacts from discharges under the Proposed Action. While Alternative 6 would eliminate any chance of drilling discharges from affected submerged archaeological or historic resources, the likelihood of significant impacts from drilling fluids and cuttings discharges under the Proposed Action is considered low. Other IPFs that could affect archaeological or historic resources would not be eliminated under Alternative 6, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on the archaeological resources as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on archaeological resources would be the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **minor** for small spills, and **moderate** for a large spill.

4.8.18. Areas of Special Concern

Potential impacts on Areas of Special Concern under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.18. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for Areas of Special Concern under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on Areas of Special Concern as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on Areas of Special Concern would be the same as those for Alternative 1 (Proposed Action): **minor** for routine activities, **negligible** for small spills, and **major** for a large spill.

4.8.19. Oil and Gas and Related Infrastructure

Potential impacts on oil and gas infrastructure under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.19. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for oil and gas and related infrastructure concern under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on oil and gas and related infrastructure as evaluated for Alternative 1.

Conclusion for Alternative 6: Impacts of Alternative 6 on oil and gas and related infrastructure would be essentially the same as those for Alternative 1 (Proposed Action): **negligible** for routine activities, **negligible** for small spills, and **minor** for a large spill.

4.8.20. Environmental Justice

Potential impacts on environmental justice communities under Alternative 6 would not differ substantially from those described for the Proposed Action (Alternative 1) in Section 4.3.20. Alternative 6 is not expected to change the total level of activity under the E&D Scenario, other than eliminating drilling discharges from 7 to 10 exploration wells and the associated necessary changes in drilling waste transportation and disposal. Drilling discharges were not identified as an IPF for environmental justice under the Proposed Action, and Alternative 6 would not change the estimated size or frequency of accidental spills. As a result, Alternative 6 would not be expected to change the likelihood or severity of impacts on environmental justice communities as evaluated for Alternative 1.

Conclusion for Alternative 6: Ratings for the impacts of Alternative 6 on environmental justice communities would be the same as those for Alternative 1 (Proposed Action): disproportionately high and adverse for a large spill.

4.9. Unavoidable Adverse Environmental Effects

Section 102(2)(c)(ii) of NEPA requires an EIS to disclose any adverse environmental effects that cannot be avoided should the Proposed Action be implemented. 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. A large spill and a VLOS are not considered in this section because they are not considered unavoidable. Small spills are considered here because although accidental, they are relatively common and their effects may be considered unavoidable. Resources that are not anticipated to have unavoidable adverse effects as a result of the Proposed Action are excluded.

- Air quality: Increased air pollutant concentrations due to emissions from engines and generators on drilling rigs, platforms, vessels, and helicopters.
- Water quality: Turbidity due to seafloor disturbance and drilling discharges; water quality impacts from operational discharges; localized elevated hydrocarbon concentrations in water and sediments from small spills.
- Acoustic environment: Underwater noise from seismic surveys, drilling and construction activities, and support vessels; noise from small spill response and cleanup activities.
- Lower trophic level organisms: Burial of benthic organisms due to seafloor disturbance at drilling rig and platform sites; burial and smothering of benthic organisms near exploration wellsites; plankton entrainment and impingement by cooling water intakes.
- Fish and shellfish: Alteration of demersal fish habitat due to seafloor disturbance at rig and platform sites and drilling discharges at exploration wellsites; entrainment and impingement of fish eggs and larvae by cooling water intakes; localized lethal and sublethal effects of small spills.
- Marine mammals: Disturbance by underwater noise from seismic surveys, drilling activities, and vessel and helicopter traffic; risk of vessel strikes; localized lethal and sublethal effects of spills.
- Terrestrial mammals: Disturbance by onshore support activities, onshore pipelines, helicopters, and oil spills.
- Birds: Attraction to OCS structures and lights, including risk of bird strikes; localized lethal and sublethal effects of small spills.
- Economy and population: Economic impacts through resource damage and disruption of fishing, marine transportation, and port operations from small spills.
- Commercial fishing: Exclusion of fishing boats from zones around drilling rigs and platforms; potential interactions with drift gillnetting, including gear loss or damage; effects of discharges and spills on fishery species.; disruption of fishing by small spill response and cleanup activities.
- Subsistence harvest patterns: Interactions with subsistence users; unavoidable effects on birds and marine mammals cause effects on subsistence harvest patterns.
- Sociocultural systems: Cultural perceptions of increased oil and gas activity, and increased population, infrastructure, and revenue associated with oil and gas development causes distress; disruption of harvesting by small spill response and cleanup activities.
- Recreation, tourism, and visual resources: Interactions with marine boating and recreational users; visual and aesthetic impacts from OCS structures and lights; contamination or temporary closure of recreational areas due to small spills.
- Sport fishing: Exclusion of fishing boats from zones around drilling rigs and platforms; effects of discharges and small spills on fishery species; localized disruption of fishing by small spill response and cleanup activities.
- Archaeological resources: Contamination of coastal historic and prehistoric sites from small spills.

4.10. Relationship Between Short-Term Uses and Long-Term Productivity

Section 102(2)(c)(iv) of NEPA requires that an EIS include information on the relationship between local short-term uses of the human environment and the maintenance and enhancement of long-term productivity, should the Proposed Action be implemented.

The impact analysis found that oil and gas exploration, development, production, and decommissioning activities would entail some impacts to nearly all of the 20 resource categories analyzed. Most impacts of routine operations are the result of short-term uses and are greatest during the exploration, development, and early production phases. These effects may be reduced by the mitigation measures included in the action alternatives and are not expected to adversely affect long-term productivity. A large oil spill could cause long-term impacts to a variety of resource areas, including fish and shellfish, marine mammals, birds, coastal and estuarine habitats, subsistence harvest patterns, sociocultural systems, recreation and tourism and visual resources, Areas of Special Concern, archaeological resources, and environmental justice communities. The potential for such impacts on long-term productivity exists under each action alternative.

Oil and natural gas production from the Cook Inlet OCS would yield short-term economic benefits, but the resulting greenhouse gas emissions would also contribute to global climate change, which is expected to cause long-term impacts to global productivity. Important consequences of climate change include sea level rise, coastal erosion, changes in ocean heat content, ocean acidification, shifts in the amount and distribution of precipitation, changes in ice extent and snow melt, changes in stream flow and runoff patterns, changes in the timing of spring events such as bird migration and egg-laying, poleward shifts in ranges of plant and animal species, and changes in the frequency and intensity of storm events. In Alaska, ecosystems are at risk from loss of ice-cover and permafrost as well as the resultant slow rise in sea level in coastal areas. It is reasonable to expect that climate change will affect long-term productivity of the marine and coastal environment of Cook Inlet.

4.11. Irreversible and Irretrievable Commitments of Resources

Section 102(2)(c)(v) of NEPA requires that an EIS include information on any irreversible and irretrievable commitments of resources that would be involved in the Proposed Action, should it be implemented. 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, as summarized in Chapter 1. This four-stage review process gives the Secretary of the Interior a "continuing opportunity for making informed adjustments" to ensure that all OCS oil and gas activities are conducted in an environmentally sound manner. In the first stage, BOEM prepares a 5-year leasing program to identify the size, timing, and location of proposed lease sales and an EIS under NEPA. In the second stage, BOEM conducts pre-lease processes and sale-specific NEPA review. The third stage involves exploration of the leased tracts. Prior to any exploration drilling, a lessee must submit an 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 DPP to BOEM for the fourth stage of review and approval.

Irreversible and irretrievable effects could occur only as a result of 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.

4.12. Impacts of a Very Large Oil Spill (VLOS)

In this section, the potential environmental, social, and economic effects of a hypothetical VLOS are examined. To facilitate analysis of the potential environmental impacts of a VLOS in Cook Inlet, it is first necessary to develop a VLOS scenario (Appendix A, Section A-7 and Appendix B). 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 the Proposed Action or its alternatives.

The VLOS scenario is predicated on an unlikely event—a loss of well control that leads to a long duration blowout and a resulting VLOS. 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, 2016, Figure 3.3-1). The low "geological" 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 and production 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, no bridging, etc.). The VLOS discharge quantity is, therefore, not "risked" or reduced by the very low frequency for the occurrence of the event.

The VLOS Scenario assumes a hypothetical spill of 120,000 bbl of oil. To analyze potential impacts of a VLOS scenario (described in Appendix A, Section 7), five phases are described from the initial event to long-term recovery (Table 4.12-1). Within each phase are one or more components that may cause impacts to the environment (i.e., IPFs). Impacts by phase are described in terms of the oil spill itself and the activities occurring within each phase (e.g., increased vessel traffic; use of dispersants during spill response activities). This approach is consistent with that used in the Final Second Supplemental EIS for Lease Sale 193 (USDOI, BOEM 2015e) and relevant only to the VLOS scenario, in which oil is hypothetically released at an average rate of 1,500 bbl per day for 80 days.

As summarized in Section 4.2.14 (and described in detail in Appendices A and B), BOEM has conducted OSRA modeling to estimate the percent chance of a large spill contacting a particular resource within a particular time period and season in Cook Inlet and the surrounding region. The regional OSRA study area is shown in Appendix A, Map A-1. A particular resource may be described by ERAs, LSs, or GLSs as shown in Table 4.2.14-4. Conditional probabilities resulting from the OSRA refer to the condition (assumption) that a VLOS has occurred. Combined probabilities are not relevant to the VLOS analysis. Further details are provided in Section 4.2.14 and Appendices A and B.

The percent chances of contact to resources within 3 and 30 days in summer and winter are provided in Section 4.3 for large oil spills. There are some differences between this VLOS analysis and BOEM's earlier analysis of a large oil spill in Section 4.3. 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 proposed Lease Sale Area. No special OSRA run was conducted to estimate the percentage of trajectories contacting resources from a hypothetical future catastrophic blowout and moderate-volume, long-duration flow resulting in a VLOS. The OSRA calculations are run for as long as 110 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 ERA, LS, GLS, or boundary segment. Higher percentages of trajectories contacting a given location could mean more oil reaching the location depending on weathering and environmental factors. For the purpose of analyzing potential impacts of a VLOS in this section, the percentage of trajectories within 110 days during summer and winter are summarized for each resource.

Table 4.12-1. Phases of the Hypothetical VLOS Scenario to be Used for Impact Analysis.

Phase		Potential Events and IPFs
1	Initial Event	Loss of well control, blowout, and/or explosion Fire (lasting up to 2 days) Seafloor disturbance – Redistribution of seafloor sediments may result from explosion and/or possible sinking of offshore rig Rescue and treatment of workers and/or the public Psychological/social distress
2	Offshore Spill	Contact with oil – Oil may be in the atmosphere, at the sea surface, in the water column, and/or on the seafloor and come in contact with resources 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
3	Onshore Contact	Contact with oil – Onshore resources may come in direct contact with 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	Spill Response and Cleanup	Vessels – Could be used to support spill response and cleanup activities Aircraft – Could be used to support spill response and cleanup activities Dispersants – Could be employed as a response strategy and intentionally introduced into the environment (likely at the sea surface, applied using aircraft or vessels) *In situ* burning – Could be employed as a response strategy in which oil at the sea surface is intentionally ignited Skimming – Could be employed as a response strategy in which specially equipped vessels are used to skim oil from the sea surface Booming – Could be employed as a response strategy in which response personnel deploy booms (long rolls of oil absorbent materials that float on the surface) in an effort to contain oil Animal rescue – Animals may be hazed or captured and sent to rehabilitation centers Beach cleaning – Cleanup efforts used on shorelines contacted by oil could include excavation, hot water washing, manual cleaning using oil absorbent materials, and/or placement and recovery of sorbent pads Drilling relief well – A relief well could be drilled by the original drilling vessel or by a second vessel with additional support Use of local and regional resources – Funds, manpower, equipment, and other resources could be used for spill response and thus unavailable for other purposes Bioremediation – Could be employed as a strategy to remove or neutralize pollutants using organisms (e.g., microbes that degrade oil)
5	Post-Spill, Long-Term Recovery	Unavailability of 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 Use of local and regional resources – Funds, manpower, equipment, and other resources could be used in recovery efforts and thus unavailable for other purposes Psychological/social distress Definitions of “long-term” and “recovery” will vary by resource

4.12.1. Air Quality

A VLOS and the associated emissions from spill response and cleanup activities could affect air quality in the Cook Inlet region regardless of the location or cause of the event. A VLOS would result in emissions over a larger area and a longer period of time than would small or large accidental spills as described in Section 4.3.1. The impact to air quality at any given location in the VLOS scenario would largely depend on the meteorological conditions such as wind speed and direction, but would largely be limited to the first two phases of the VLOS.

The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on air quality are described in the following sections.

4.12.1.1. Phase 1 (Initial Event)

Phase 1 would create emissions of VOCs from hydrocarbon evaporation. Total ambient VOC concentrations would be high in the immediate vicinity of the spill or blowout, but would decrease quickly due to dispersion of the oil spill and of VOCs by winds, waves, and currents. An explosion or fire would cause an increase in concentrations of criteria pollutants that would temporarily affect air quality, including moderate concentrations of PM and black carbon soot that could degrade visibility in nearby areas. VOC concentrations would be high in the immediate vicinity of the fire; however, these concentrations would be lower than those associated with a non-burning spill because the fire would combust fuel that would otherwise evaporate. A major portion of the pollutants, including PAHs, would be consumed in the burn. A fire would also create soot that would cling to plants near the fire but would wash off in subsequent rains. Exposure would be limited by the distance of the spill event to shore. After the burn, air quality would rapidly return to pre-spill conditions and criteria pollutant concentrations would return to levels within the NAAQS. Moderate winds would further reduce VOC concentrations and speed up the dispersion of contaminants.

4.12.1.2. Phase 2 (Offshore Spill)

Oil slicks on the sea surface would result in evaporative emissions of VOCs until the sea surface is clear of oil or most of the volatile hydrocarbons are depleted. Oil in the water column would not be in contact with air and would therefore not affect air quality. VOC concentrations would be elevated over a slick of spilled oil, but the majority of volatilization would occur immediately and would not likely impact air quality beyond the immediate vicinity of the VLOS event. Warmer temperatures increase the rate at which VOCs evaporate and also reduce the oil's viscosity, allowing it to spread out over a larger surface area, reducing the time it takes for VOCs to evaporate. Air quality effects over the ocean would be greatest at the source of the spill where the oil layer is thickest and VOC emissions are greatest. Effects would decrease in magnitude with increasing distance from the source. Other affected offshore resources may require mitigation or response actions, which could result in vessels and equipment operating and creating minor pollutant emissions in areas that would not have emissions sources under normal operation. The air quality would be affected only slightly by these activities.

4.12.1.3. Phase 3 (Onshore Contact)

Harmful evaporative emissions from the oil slick itself would most likely be minimal by the time oil reaches the shore. Onshore resources in contact with spilled oil would require mitigation or response actions such as beach cleaning and animal rescue, which would involve vehicles, vessels, and equipment that cause additional emissions. These emissions would most likely be minor and would not permanently alter air quality.

4.12.1.4. Phase 4 (Spill Response and Cleanup)

Emergency response and cleanup of a spill or accidental release would result in a slight emissions increase due to elevated activity of vessels and equipment in the area of the release. Operators would have to mechanically contain and clean up the spill as much as possible, which would result in operation of additional vessels and equipment not typically used in routine operations, including aircraft, skimming and booming vessels, and equipment for drilling of relief wells. The impact of these emissions would most likely be very small and localized to the immediate area of response activity. In certain cases, *in situ* burning may be used as a technique for cleanup and disposal of spilled crude or diesel oil. The effects of *in situ* burning are the same as for an accidental fire as described earlier.

4.12.1.5. Phase 5 (Post-Spill, Long-Term Recovery)

Concentrations of VOCs and criteria pollutants would return to ambient levels quickly following the initial event, and air quality would not be permanently affected in the region. Emissions from cleanup vessels and equipment would continue as long as the spill response is ongoing, but would most likely not have an effect on air quality.

4.12.1.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percentage of trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days during the VLOS release.

4.12.1.7. Conclusion

The effects of a VLOS on air quality would be **minor**. The VLOS would cause small localized increases in VOC concentrations in the air, which may be reduced substantially by *in situ* burning. Minor emissions of other criteria pollutants such as NO_2, SO_2, CO, and PM would result from the burning or flaring of spilled oil and gas as well as from increased vessel and equipment usage in spill response and mitigation activities. Visibility impacts due to smoke plumes may occur. Due to dispersion, impacts on air quality would be limited to the immediate area of the spill and are expected to be temporary. Concentrations of criteria pollutants would likely not exceed air quality standards in any onshore areas.

4.12.2. Water Quality

Potential impacts to water quality from a VLOS would be similar to those described in Section 4.3.2 for large accidental spills, but greater in potential severity and spatial extent owing to the volume and duration of the hypothetical release. The hypothetical VLOS scenario would directly impact surface and subsurface water quality in the vicinity and downstream of the release for three months, both while the oil is flowing and for about 30 days after the flow ceases.

This section describes the potential impacts of a VLOS on water quality in Cook Inlet and is partially based on what was learned during and after the prolonged oil release of the *Deepwater Horizon* spill in the Gulf of Mexico in 2010. *Deepwater Horizon* findings are reviewed to provide an understanding of the potential persistence of oil in the water column and its impacts on water quality. However, water depths at which offshore oil and gas activities may occur in Cook Inlet (<100 m (328 ft)) are far shallower than those in the Gulf of Mexico. Seasonality, weather, wind patterns, sea ice, and surface water temperatures of Cook Inlet are also substantially different than those in the Gulf of Mexico and will affect the behavior and fate of spilled oil. At the surface, colder temperatures in Cook Inlet would increase oil viscosity, alter decomposition patterns, and slow remediation processes. Section 4.2.14 and Appendix A provide details on the estimated fate and behavior of spilled oil in Cook Inlet.

Subsurface oil persisted in the deep-water environment for months after the initial *Deepwater Horizon* release, at least partially due to the injection of dispersant at the wellhead. Two months into the *Deepwater Horizon* oil spill, Camilli et al. (2010) and others documented a near-continuous subsurface oil plume at a depth of approximately 1,100 m (3,610 ft) that extended for 35 km (22 mi) downstream (southwest) of the release site. Monoaromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylene) were found at concentrations greater than 50 micrograms per liter (µg/L) in water samples from these depths. High concentrations of aromatic hydrocarbons were also found in the upper 100 m (328 ft) of the water column. Dierks et al. (2010) found PAHs in concentrations reaching 189 µg/L at depths between 1,000 and 1,400 m (3,281 and 4,594 ft), extending as far as 13 km (8 mi) from the subsurface release site. Joye et al. (2011) estimated that 500,000 tons of hydrocarbon gases were released at depth and found concentrations of methane, ethane, propane, butane, and pentane in water samples collected between 1,000 and 1,300 m (3,281 and 4,265 ft) depth, exceeded background concentrations by up to 75,000 times. Yvon-Lewis, Hu, Kessler (2011) concluded the majority of methane from the release remained dissolved in deep ocean waters. Valentine et al. (2010) reported that two months after the *Deepwater Horizon* release, propane and methane at depth were the major gases driving rapid respiration by bacteria. Biodegradation by deepwater methanotrophs following the *Deepwater Horizon* incident was studied by Kessler et al. (2011), who 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 two to three months after the incident.

In the summer, Cook Inlet is stratified (Okkonen, Pegau, and Saupe, 2009), which could make conditions more conducive to the formation of subsurface plumes (Rudels, Larsson, and Sehlstedt, 1991; Rye, Brandvik, and Strøm, 1997). Oil would be subjected to natural weathering processes, including microbial degradation (Kinney, Button, and Schell, 1969), as methane and petroleum hydrocarbon degraders are present and active in ice, water, and sediment (Atlas, Horowitz, and Busdosh, 1978; Braddock, Gannon, and Rasley, 2004; Damm et al., 2007; Gerdes et al., 2005).

The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on water quality are described in the following sections.

4.12.2.1. Phase 1 (Initial Event)

Disruption of seafloor sediments due to an explosion associated with the initial event would increase turbidity. Resuspended seafloor sediments would also mobilize any contaminants present in the sediment and introduce them to the water column. As described in Section 4.3, gas released in the initial event would alter water quality temporarily and could affect processes and reactions in the microlayer at the water-air interface.

4.12.2.2. Phase 2 (Offshore Spill)

As described in Section 4.3, spilled oil and the associated VOCs and PAHs would affect water quality at the sea surface and in the water column until the oil degrades, dilutes, and disperses. Some oil may be deposited in sediments or form floating tarballs that eventually settle to the seafloor. These persistent forms of oil in the water column could affect water quality for months after the flow of oil ceases. Ice contaminated by oil could drift for long distances, transporting relatively unweathered oil; once the ice melts, it will release the oil into the water. OSRA results in Appendix A estimate that a percentage of trajectories from a VLOS could contact as far south as Shelikof Strait and east of Kodiak Island within 110 days during the initial release. As described in Section 4.2.14 and Appendix A, the OSRA model is based on the movement of unweathered oil with no mitigation from oil spill response activities. Weathering calculations suggest that the processes of dispersion and evaporation would naturally reduce the amount of surface oil (Appendix A, Table A.1-28).

4.12.2.3. Phase 3 (Onshore Contact)

Oil that contacts that shoreline can be mixed into the nearshore and beach sediments then remobilized and dispersed, causing persistent elevation of hydrocarbon concentrations in nearshore waters.

4.12.2.4. Phase 4 (Spill Response and Cleanup)

Spill response activities that could be performed are described in Section 4.2.14.3. Potential impacts to water quality resulting from mechanical recovery, dispersant use, *in situ* burning, drilling a relief well, booming, and beach cleaning are described in this section.

Mechanical recovery of oil will result in more vessel traffic and potential impacts on water quality owing to deck drainage, sanitary and domestic discharges, brine and cooling water discharges, accidental spills, anchoring in benthic habitat, disturbance of the microlayer, and potential for introduction of invasive species from foreign or out-of-state vessels. In winter, ice-breakers could also affect the movement of spilled oil that may be trapped beneath or in the ice.

Application of chemical dispersants to oil results in the reduction of oil droplet sizes, which decreases droplet buoyancy and increases the surface area available for microbial degradation. Dispersants are used with the intention of reducing the amount of oil that reaches shorelines (Word, Pinza, and Gardiner, 2008). Oil droplets remaining in the water column can be mixed downward, adhere to sediments, and settle to the seafloor, affecting water quality as described in Phase 2. The addition of chemical dispersants will also directly impact water quality, and chemically dispersed oil may be more toxic than physically dispersed oil (NRC, 2005b).

In situ burning is a response technique used to ignite and volatilize surface oil to remove oil from the sea surface. *In situ* burning temporarily increases surface water temperatures, particularly affecting the microlayer at the air-water interface where important chemical, physical, and biological processes occur, including habitat for many sensitive life stages and microorganisms (GESAMP, 1995). Residues from *in situ* burning can float or sink, depending on environmental conditions and the constituents of the residue. Floating residue can be collected, but 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 expects *in situ* burning impacts to be less severe than those resulting from exposure to a large uncontained oil spills (NOAA, 2011). If a VLOS occurred in winter and *in situ* burning on water with ice occurred, the ice would melt in the immediate vicinity of the burn.

In addition to the impacts from vessel activity described previously, drilling an emergency relief well would entail discharge of drilling fluids and cuttings, increasing turbidity and contaminants in the water column and sediments. Discharges regulated by the EPA under an NPDES permit would cause additional impacts like those described in Section 4.3 for routine activities.

A number of response activities conducted on beaches and in nearshore areas could result in the degradation of coastal waters, including the deployment and retrieval of boom, the cleaning of oiled beaches, the collection of oil vegetation, the rescue of oiled animals, and the raking of fine sediments. Hydraulic washing with hot water and application of fertilizer to oiled environments has been practiced and could occur. 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 people and small boats mobilized from outside the area.

4.12.2.5. Phase 5 (Post-Spill, Long-Term Recovery)

During this phase, there could be reoccurring visitation by monitoring and research personnel, which could result in continued impacts similar to those described for beach cleaning. Over the long term, contamination of aquatic environments could continue due to oil leaching from sediments and resuspended oil. Residues and contaminated deposits on the seafloor could continue leaching into benthic waters.

4.12.2.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percentage of trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days of the VLOS release.

4.12.2.7. Conclusion

A VLOS would cause sustained degradation of water quality from hydrocarbon contamination in exceedance of state and Federal water and sediment quality criteria. Additional effects on water quality would occur from response activities, including an increased number of vessels and direct treatments to the environment such as *in situ* burning, dispersant application, and drilling of a relief well. The impacts to water quality in Cook Inlet from a VLOS could continue for months to years until the released oil is entirely dispersed, degraded, weathered, and cleaned up from the shoreline. The potential impacts of a VLOS on water quality in Cook Inlet would be severe and are deemed to be **major**.

4.12.3. Acoustic Environment

Impacts to the acoustic environment from a VLOS would result from increased vessel and aircraft activity and equipment use involved in oil spill response. These impacts would result in a temporary increase in noise levels within the acoustic environment, which are expected to be concentrated in the low-frequency ranges (<100 Hz) and be widespread throughout the proposed Lease Sale Area for the duration of the response activity. As described in Section 4.3, increased noise levels can result in loss of acoustic habitat accessibility for some species. The extent and duration of a VLOS can reach well beyond the proposed Lease Sale Area and may require several months of high-intensity vessel traffic and subsea operations. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on the acoustic environment are described in the following sections.

4.12.3.1. Phase 1 (Initial Event)

Phase 1 is likely to contribute localized, high source level sounds into the water through explosions, loss of well control, or loss/sinking of the structure. These events would impact the acoustic environment in a severe but very short-term and recoverable manner. Immediately after the initial event, there will be an influx of vessels, aircraft, and equipment to the site, which would increase noise in the environment. The source levels and frequencies of this noise will propagate long distances. Although the initial response is likely to markedly impact the acoustic environment, based on the temporary nature of the event and sound source level contributions expected in this phase, impacts to the acoustic environment are predicted to be minor.

4.12.3.2. Phase 2 (Offshore Spill)

Similar impacts to the acoustic environment owing to increased vessel traffic in Phase 1 would continue into Phase 2 but are expected to be negligible.

4.12.3.3. Phase 3 (Onshore Contact)

Although nearshore and onshore activities may affect the localized acoustic environment, impacts are expected to be negligible during Phase 3.

4.12.3.4. Phase 4 (Spill Response and Cleanup)

Phase 4 will require fleets of vessels and in-water equipment, all of which will be conducting specific operations to contain, track, remove, and sample the oil spill environment. Operational vessels may include oil spill response and recovery tugs, barges, and vessels; oil storage tankers; boom and skimmer units; ROV vessels; and sampling vessels. Depending on the extent of the spill and the response plan, the extent of noise contributions from these vessels could be hundreds of square kilometers in Cook Inlet and the surrounding region. The source levels and frequencies from response equipment and vessels could produce high sound source levels that could propagate long distances. The impacts to the acoustic environment will be temporary, although activities may continue for months after the initial spill. Upon conclusion of the response activities, the acoustic environment will return to pre-spill conditions. Although the impacts are temporary, due to the severity of the temporary changes to the extended acoustic environment, impacts are expected to be moderate for Phase 4.

4.12.3.5. Phase 5 (Post-Spill, Long-Term Recovery)

Phase 5 will involve some of the same sources as Phase 4 but far fewer and less concentrated vessels operating for specific short-term activities. Impacts to the acoustic environment would be temporary but of long duration (potentially years). Long-term monitoring vessels likely would not pose significant additions of noise above existing background levels of vessel activity. Some monitoring along shorelines or in remote locations may introduce low-frequency noise with a short temporal footprint. When completed, the acoustic environment would return to pre-spill conditions. Impacts to the acoustic environment are expected to be negligible for Phase 5.

4.12.3.6. Oil-spill Risk Analysis

The OSRA model conditional probabilities in Appendix A estimate that a percentage of trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days during the VLOS release.

4.12.3.7. Conclusion

Potential impacts to the acoustic environment from a VLOS would primarily occur as a result of increased vessel traffic and equipment use while responding to the spill. Impacts would mainly occur in the low-frequency ranges with continuous sound sources. Some impulsive sources, particularly active acoustic sources such as those used in multibeam and high-resolution surveys could occur in all phases. Response will produce short-term and prolonged impacts on the soundscape of Cook Inlet, including increases in noise in the acoustic environment as vessels and aircraft move through the area. During peak activity, there may be prolonged loss of frequency bands and thus loss of acoustic habitat availability for some species. Species may react to these impacts to acoustic habitat depending on the importance of the habitat and their sensitivity to the produced source levels and frequencies. Although some of these spikes in activity may be extreme, producing high SPLs, the acoustic habitat will return to pre-event conditions when all phases are completed. Due to the temporary nature of the peak activity and sound production during response, impacts to the acoustic environment as a result of a VLOS are expected to be **minor**.

4.12.4. Lower Trophic Level Organisms

Potential impacts to lower trophic level organisms from a VLOS would be the same as described in Section 4.3.4. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on lower trophic organisms are described in the following sections.

4.12.4.1. Phase 1 (Initial Event)

The potential IPFs that could affect lower trophic organisms during this phase include an explosion, fire, and increases in vessel traffic. An explosion and fire would increase temperatures, cause major disruption of the seafloor and water column, and release chemicals near the wellhead, likely resulting in a loss of pelagic and epibenthic lower trophic organisms proximal to the incident site. Impacts distal to the wellhead would depend on the magnitude of the explosion. Sediment redistribution could affect organisms in the water column owing to increased turbidity and could bury benthic and epibenthic organisms when sediments resettle to the seafloor.

4.12.4.2. Phase 2 (Offshore Spill)

Direct exposure to oil and gas is the critical IPF potentially affecting lower trophic organisms during this phase. An offshore oil spill would directly affect plankton communities and benthic invertebrates because they have no or limited ability to avoid contact with surface and subsurface oil. The potential effects of oil exposure on phytoplankton, zooplankton, microbial communities, and benthic invertebrates are described in detail in Section 4.3.4, including mass die-offs, impaired growth and behavior, and effects on populations (both negative and positive for some microbes). These potential impacts could extend for hundreds of square kilometers during a VLOS, owing to the volume of oil released and the duration of the spill, affecting lower trophic organisms in Cook Inlet and the surrounding region. The magnitude and duration of impacts depends on the hydrodynamic regime at the incident location and in areas to which the oil is transported. Mixing and tidal flushing would dilute spilled oil and reduce the potential for exposure, while lower tropic organisms in coastal habitats such as bays and estuaries would be more susceptible to exposure and associated impacts.

4.12.4.3. Phase 3 (Onshore Contact)

Direct exposure to oil and gas is the critical IPF potentially affecting lower trophic organisms during this phase. Oil contacting intertidal and subtidal zones could result in lethal and sublethal impacts on benthic invertebrates, including adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (i.e., feeding, mating, and habitat selection) owing to exposure to oil and accumulation of oil in tissues. Chronic contamination of nearshore benthic communities could occur if oil persists on beaches and in shallow nearshore sediments.

4.12.4.4. Phase 4 (Spill Response and Cleanup)

Disturbance and displacement owing to human, vessel, and aircraft traffic and noise are the critical IPFs potentially affecting lower trophic organisms during this phase. As described in Section 4.12.2.4, the use of chemical dispersants during spill response would directly impact water quality, thereby also potentially affecting pelagic and epibenthic lower trophic organisms in the vicinity of the dispersant use and in areas to which chemically dispersed oil may be transported. Increased vessel activity and potential production of residues from *in situ* burning could also affect water quality and expose lower trophic organisms to contamination and adverse effects. Response activities conducted on beaches and in nearshore areas, including the deployment and retrieval of boom as well as the cleaning of oiled beaches (particularly hydraulic washing with hot water), could adversely affect nearshore benthic communities through resuspension of hydrocarbons, runoff of treatment-laden waters, burial, and physical destruction.

4.12.4.5. Phase 5 (Post-Spill, Long-Term Recovery)

Persistent oil contamination is the critical IPF potentially affecting lower trophic organisms during this phase. As described in Section 4.3.4, the short life cycles of plankton usually enable a relatively rapidly recovery to normal population levels following disturbances. It is unlikely that planktonic communities would experience long-term population-level effects. However, benthic invertebrates are susceptible to long-term exposure and can accumulate contaminants, resulting in adverse local and potentially population-level effects, particularly if oil persists in coastal habitats important to nearshore benthic communities. Many shorelines in Cook Inlet and the surrounding area have high ESI shore types such as coastal marshes and mud flats, in which oil could persist for years. Another principal shore type in the area, armored cobble beaches, can trap oil and impede weathering for years, potentially exposing nearshore benthic communities to persistent exposure to contaminants leached from oiled beaches.

4.12.4.6. Oil-spill Risk Analysis

Lower trophic level organisms in Cook Inlet and the surrounding region are represented in the OSRA model by ERAs and GLSs listed in Table A.1-13 of Appendix A. A summary of the highest percentage of trajectories contacting these lower trophic level resources within 110 days during summer and winter is provided in Table 4.12.4-1. Augustine Island, Polly Creek Beach, Chinitna Bay, and the Barren Islands (ERAs 11, 153, 154, and 155 shown in Map A-2a of Appendix A) are areas considered important for lower trophic level organisms that could be exposed to oil during the hypothetical VLOS scenario. As shown in Table A.1-13 of Appendix A, Augustine is an important area for clams, scallops, and seagrass; Polly Creek Beach is an important area for clams and seagrass; Chinitna Bay and the Clam Gulch Critical Habitat Area are important areas for clams; and the Barren Islands are important areas for crabs. The OSRA model estimates these areas have the highest percentage of trajectories contacting them, and therefore are the most at risk for oil exposure, potential effects of contamination, and potential impact. Additional discussions of potential impacts to shellfish can be found in Section 4.12.5.

Table 4.12.4-1. Highest Percentage of VLOS Trajectories Contacting Lower Trophic Level Resources[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer	Winter
		110 days[2]	110 days
Environmental Resource Area (ERA)	≥6–<25	154 (Chinitna Bay) 155 (Barren Islands)	154 (Chinitna Bay) 155 (Barren Islands)
	≥50	11 (Augustine) 153 (Polly Creek Beach)	11 (Augustine) 153 (Polly Creek Beach)
Grouped Land Segment (GLS)	≥6–<25	138 (Clam Gulch Critical Habitat)	138 (Clam Gulch Critical Habitat)

Notes: [1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) are the same as the highest percentage of trajectories in 110 days in both seasons, but the individual results from each LA may not be identical.

Source: Appendix A (Tables A.1-13, A.2-25, A.2-35, A.2-45, and A.2-55). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

4.12.4.7. Conclusion

Potential impacts of a VLOS on lower trophic level organisms near the incident site could be severe and include lethal and sublethal effects on pelagic and epibenthic organisms. Population-level impacts are not likely for offshore plankton communities, although a winter spill would require a longer recovery period. Pelagic invertebrates are at greater risk owing to slower reproductive rates and longer life spans. Benthic invertebrates are susceptible to long-term exposure and can accumulate contaminants, resulting in adverse local and potentially population-level effects, particularly if oil persists in coastal habitats important to nearshore benthic communities. Oil reaching the shoreline (regardless of season) could result in long-term, persistent impacts to benthic invertebrates. Overall impacts to lower tropic level organisms from a VLOS could be **major** depending on the timing, location, and environmental conditions at the time of the incident.

4.12.5. Fish and Shellfish

In the unlikely event that a VLOS were to occur in the proposed Lease Sale Area, the nature and magnitude of impacts to fish and shellfish would depend on the timing, location, species, life stages, and habitats exposed to a VLOS. Potential impacts of a VLOS on fish and shellfish populations would be similar to the impacts described for a large oil spill (Section 4.3.5), but the area affected and the number of species, individuals, and habitats affected by a VLOS would be greater and the degree of impact more severe. Population-level impacts for some species could be incurred if the VLOS affects extensive areas of shoreline and benthic substrate.

Offshore and nearshore fish species exposed to oil could be affected by acute toxicity and 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. Early life-history stages of fish and shellfish species would be particularly vulnerable to effects at individual and population levels. Forage fishes such as Pacific herring and walleye pollock most likely would suffer significant impacts due to the coastal spawning habits of adults and the use of pelagic nursery areas. Effects to forage fish populations may persist from oil trapped in subtidal and intertidal sediments for more than a decade, thereby impacting additional cohorts and generations. Such effects may result in important impacts to other species of fisheries resources, seabirds, and marine mammals, thereby altering ecosystem dynamics and community structure. Some salmonid and shellfish subpopulations may experience significant declines within Cook Inlet and the Gulf of Alaska that collectively lead to measurable and significant impacts in the overall population, requiring multiple generations to recover to their former status.

The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on fish and shellfish are described in the following sections.

4.12.5.1. Phase 1 (Initial Event)

The potential IPFs that could affect fish and shellfish during this phase include an explosion, fire, and increases in vessel traffic. An explosion could affect the pressure, density, and temperature of the water column. Additionally, fish eggs, larvae, and adults on the seafloor and in the water column proximal to the explosion could experience lethal effects. Fish injured by the explosion (e.g., damage to lateral lines and swim bladders) would have physical, physiological, and behavioral effects that could interfere with swimming, feeding, reproduction, and predator escape. An explosion would damage benthic habitats as well as cause high levels of suspended sediment and turbidity, which in turn could affect fish physiology. Acute or chronic injuries could result in longer-term population effects if a large proportion of individuals were affected. Water quality and visibility would also be negatively affected by turbidity in the immediate area.

A fire would increase surface water temperatures and could be lethal for epipelagic fish, eggs, and larvae. Subsurface egg and larvae mortality could occur over time if the fire was prolonged and affected subsurface water temperatures and water quality. Chemical characteristics of the water, including oxygen concentration, could be altered by rising temperatures, which could also affect fish physiology. A sunken drilling rig could physically impact the seafloor habitat, and longer-term impacts could occur if materials leach into the water column. If the rig broke apart and drifted across the seafloor, alteration of structural habitat could result.

The relative effects on demersal and pelagic fish would depend on the location of the explosion (i.e., at the seafloor, mid-water, or at the sea surface). Sensitive life stages in the surface waters, such as pelagic eggs and drifting fish larvae, would be particularly affected by the explosion (e.g., shock wave, methane) and fire (e.g., heat, chemical reactions). Impacts to fish in the immediate vicinity of a drilling structure are anticipated during Phase 1. Only a small number of vessels and helicopters would be involved in rescue efforts, which would result in a negligible increase in traffic and noise impacts to fish and shellfish. Free-swimming fish not obligated to a specific habitat would likely move out of the affected area.

4.12.5.2. Phase 2 (Offshore Spill)

Direct exposure to oil and gas as well as contamination of habitat and prey resources are the critical IPFs potentially affecting fish and shellfish during this phase. Oil in offshore waters of Cook Inlet would be a serious threat to pelagic fish and shellfish because of its properties of forming a layer on the sea surface. Pelagic fish and shellfish larvae and juveniles (zooplankton) are most vulnerable to oil spills occurring offshore because they spend the majority of their time close to the sea surface and are at the whim of currents. The effects likely would be worse during the summer months because of the greater number of juvenile fish and shellfish present in the zooplankton community compared to winter.

Fish and shellfish mortality due to oil spills are described in Section 4.3.5 and arise from direct contact resulting in acute and chronic effects. Oil ingested during feeding can lead to tissue and organ damage as well as interference with food detection, predator avoidance, homing of migratory species, disease resistance, growth rates, reproduction, and respiration.

Contamination of prey organisms would also be expected to occur, resulting in modified prey abundance and ingestion of contaminated prey items (see Sections 4.3.4 and 4.12.4 for a discussion of the potential impacts of oil exposure on lower trophic level organisms). This contamination would be expected to affect a large area of a fish foraging range for multiple months and could reduce growth, survival, or reproductive success for some fish and shellfish species. Many of the fish and shellfish that likely would be affected by this impact probably would die from contact with the oil itself. Fish and mobile shellfish could be displaced to potentially less productive secondary foraging locations.

Offshore demersal and pelagic fish species such as Arctic cod, capelin, Alaska plaice, yellowfin sole, and certain species of sculpin and flounder would experience a variety of effects from a VLOS. Sedentary, burrowing, territorial, benthic-oriented 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, and spatial limitations. The exposure concentration that these species, including some poachers, eelpouts, sculpin, flounders, and snailfish, would experience could be greater than that to which free-swimming fish would be exposed. Fish that can swim relatively faster and more efficiently (e.g., salmon, cod, smelt, herring, 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.

4.12.5.3. Phase 3 (Onshore Contact)

Direct exposure to oil and gas as well as contamination of habitat and prey resources are the critical IPFs potentially affecting fish and shellfish during this phase. Large numbers of fish and shellfish could come into contact with spilled oil along shoreline areas, in estuaries, and in bays, and they could be affected through direct contact with oil, ingestion of contaminated prey, or mortality of prey resources. Such mortality could have population-level effects because large numbers of nearshore fish and shellfish could be affected. Oiling of coastal habitats with concentrations of spawning fish would be expected to cause displacement of fish and contribute to reduced reproductive success of the fish. Reproductive impacts are of particular significance in the short summer period found at northern latitudes and the high-energetic investment in spawning. Forage fish such as herring would be severely impacted, and ramifications up the food chain could impact predator fish for many generations.

Anadromous fish, because they depend on several environments in their complex life history, could be particularly impacted if oil reaches the mouths and deltas of streams and rivers where it could impede access to spawning, feeding, overwintering, and coastwise migration. Oil could be transported upstream by tidal action and would present contaminants to sensitive spawning areas and life stages. Several fish species (e.g., capelin, sand lance, some sculpin species), although not considered anadromous, use nearshore substrates for spawning and rearing habitats. Nearshore species would be affected through similar pathways as anadromous fish if oil contacted the shoreline, particularly during critical spawning or rearing times. Sand lance could be especially affected by nearshore contamination, because they burrow in sand between foraging efforts and when overwintering. Acute and chronic effects on nearshore and intertidal fish, eggs, and larvae could result in longer-term population effects if a large proportion of individuals were affected.

4.12.5.4. Phase 4 (Spill Response and Cleanup)

Disturbance, contamination, and displacement resulting from spill response activities (e.g., dispersant application, *in situ* burning, beach cleaning) are the critical IPFs potentially affecting fish and shellfish during this phase. The hypothetical VLOS scenario would trigger extensive spill response and cleanup efforts, during which fish could be exposed to a variety of effects from offshore vessel traffic, including noise from ships, sound from seismic surveys, and other sound sources. As described in Section 4.3.5, this noise could 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.

Mechanical recovery activities (including skimming and booming) would disturb chemical, physical, and biological processes that take place in the microlayer and could injure or kill sensitive pelagic life stages, including fish eggs, fish larvae, and microorganisms that are important prey for fish (GESAMP, 1995). Beach-cleaning activities could result in effects on fish, including trampling of intertidal, nearshore, riverine, and riparian habitats; crushing of eggs and benthic larvae; noise and disruption causing aberrant behavior in fish; increased turbidity in nearshore waters; movement of sediment and potential exposure or burial of habitat; runoff of treatment-laden waters; and removal of intertidal hiding habitat.

Use of chemical dispersants could result in toxic and fouling effects similar to those described during Phases 2 and 3. 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.

4.12.5.5. Phase 5 (Post-Spill, Long-Term Recovery)

Persistent contamination is the critical IPF potentially affecting fish and shellfish during this phase. Many shorelines in Cook Inlet and the surrounding region are composed of armored and cobbled materials that can impede weathering as well as shorelines with a high ESI such as marshes, peat, and fine-grained sediments, to which oil adheres and persists. Biodegradation and weathering of oil at cold temperatures is slow, and could allow oil to persist for weeks to years in these habitats. Contamination of intertidal areas could lead to considerable mortality of eggs and juvenile fish. Elevated levels of developmental malformations and physiological aberrations in eggs and juvenile stages can cause reduced survival to adulthood, thereby delaying recovery of subpopulations affected by an oil spill. Organisms that rely most heavily on these environments would be most affected in the long term. In intertidal areas, these greatest potential impacts could be on Pacific herring eggs, Pacific sand lance and capelin eggs and adults, yellowfin sole, pink salmon eggs, adult squid, juvenile sablefish, walleye pollock larvae and adults, Pacific cod larvae and adults, eulachon juveniles, and Greenland turbot eggs (USDOI, MMS, 2003).

The adverse effects on fish and shellfish from direct oiling and contaminated prey (as described under Phase 2) could persist for years and lead to population-level effects in Cook Inlet and possibly the Gulf of Alaska. Chronic effects would be most evident in populations of benthic and pelagic organisms associated with kelp and eelgrass beds. Reduction in prey sources could also persist long-term; for example, the recovery of invertebrate populations could take years if impacts result in population-level effects. Persistent contamination of aquatic environments from stranded oil could cause long-term chronic effects, particularly in fish that occupy estuarine, intertidal, and freshwater habitats where oil accumulates and weathers, producing PAHs especially toxic to lipid-rich eggs (e.g., pink salmon, capelin). If chronic exposures persist, stress may manifest as sublethal effects such as 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.

Contaminant exposure can make spawning sites unavailable for multiple generations if oil is detectable by the fish. If a population continues to spawn or rear offspring in areas contaminated by oil, abnormal development, genetic alterations, or abnormal behaviors may repeat through successive generations, resulting in the survival of fewer juvenile fish, so that recruitment from the early life stages is reduced and adult populations decline. Declining adult populations may not be replaced at sustainable levels.

4.12.5.6. Oil-spill Risk Analysis

The OSRA conditional probabilities in Appendix A estimate that a percentage of trajectories from a VLOS could contact as far south as Shelikof Strait and east of Kodiak Island within 110 days of the VLOS release. Weathering calculations suggest that the processes of dispersion and evaporation would naturally reduce the amount of surface oil (Appendix A, Table A.1-28). The OSRA estimates movement of a VLOS on the surface of the ocean, but it does not assess subsurface transport of oil in water, tarballs washed onto beaches, or persistence of oil once it has reached spawning beaches, rearing areas, or spawning streams. The OSRA model does not define specific ERAs, LSs, or GLSs for offshore fish, but analysis of lower trophic level organisms (discussed in Section 4.12.4) and anadromous fish (Table 4.12.5-1) are relevant to this resource. Augustine Island, Polly Creek Beach, Chinitna Bay, and the Barren Islands (ERAs 11, 153, 154, and 155; Appendix A, Map A-2a) are areas considered important for lower trophic level organisms that could be exposed to oil during the hypothetical VLOS scenario. Demersal fish, shellfish, and juvenile fish in these areas would be at risk of exposure to spilled oil.

Anadromous fish in Cook Inlet and the surrounding region are represented in the OSRA model by LSs and GLSs listed in Table A.1-12 of Appendix A. A summary of the highest percentage of VLOS trajectories originating from any of the six LAs will contact these anadromous fish resources within 110 days during summer and winter is provided in Table 4.12.5-1. Because the probability of trajectories contacting anadromous fish resources areas is relatively low (<25%), anadromous fish in these areas are not considered to be at substantial risk, but oil contact to LSs on the west, southwest, and southeast coasts of Cook Inlet that contain rivers with anadromous runs could be adversely affected and could result in behavioral changes in these fish. The anadromous water bodies with the highest percentage of trajectories contacting them include Polly Creek, the Kamishak River, the Chinitna River, the Crescent River on the southwest side of Cook Inlet, and Deep Creek and the Chakok River on the southeast side of Cook Inlet. A few larger anadromous water bodies important to fish that have a lower percentage of trajectories contacting them include the Anchor, Kasilof, and Ninilchik Rivers.

Table 4.12.5-1. Highest Percentage of VLOS Trajectories Contacting Anadromous Fish Resources[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer	Winter
		110 days[2]	110 days
Land Segment (LS)	≥0.5–<6	16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 34, 37, 38, 40, 5455, 57, 58, 60, 63, 81, 82, 83, 84, 85, 86, 87, 111	21, 22, 23, 24, 25, 26, 27, 37, 38, 39, 40, 54, 55, 56, 57, 58, 60, 61, 63, 81, 82, 83, 84, 85, 86, 87, 88
	≥6–<25	28, 30, 31, 32, 33, 35, 36, 56, 61, 62	28, 30, 31, 32, 33, 34, 35, 36, 62

Notes: [1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) are the same as the highest percentage of trajectories in 110 days in both seasons, but the individual results from each LA may not be identical.

Source: Appendix A (Tables A.1-12, A.2-30, and A.2-50). Maps of LSs are provided in Appendix A, Maps A-3a through A-3d.

While the entrances to major salmon-spawning streams are relatively easy to identify in OSRA results, other resource areas important to fish also exist along many areas of the Cook Inlet coastline. For example, Kamishak and Tuxedni Bays encompass estuaries important to rearing fish, including out-migrating salmon smolts from Polly Creek and the Kamishak, Chinitna, and Crescent Rivers. Oil contact to LSs along the western side of Cook Inlet would impact forage fish and migrating salmonids. Oil that contacts 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 direct exposure to oil, which can cause chronic or acute effects, particularly on early life stages. Based on the percent of trajectories contacting from a VLOS and the areas contacted, the fish species most likely affected include intertidal, estuarine, and nearshore spawning and/or rearing fishes, particularly capelin, Pacific herring, sand lance, and Pacific salmon in their marine and estuarine migration and staging periods of life.

Additional analysis of potential impacts to fish in Cook Inlet is permitted by reviewing the OSRA results for marine mammals presented in Section 4.12.6, owing to the need for access to open water shared by both fish and marine mammals. Fish species in these resource areas potentially affected by oil spills are adult anadromous fishes and eulachon transiting lower Cook Inlet, out-migrating juvenile salmon entering western Cook Inlet from natal rivers and streams, Pacific herring, Pacific cod, and halibut and walleye pollock in offshore waters in western and southern Cook Inlet. Additionally, fish and shellfish pelagic eggs and juvenile stages inhabiting near-surface waters in these areas may experience lethal and sublethal effects if exposed to oil.

4.12.5.7. Conclusion

A VLOS in Cook Inlet could affect large numbers of fish and shellfish resources due to lethal and sublethal toxicity effects on larvae, individuals, and their prey. Mortality could result in population-level effects for many fish and shellfish species inhabiting Cook Inlet. Pelagic migratory fishes could also be impacted in the central Gulf of Alaska, depending on the timing and location of the spill in relation to migratory patterns. As described in Section 4.3.5, successive generations of fish and shellfish may continue to experience lethal and sublethal effects as a result of indirect impacts lasting more than a decade, and subpopulations within the study area may experience declines that require multiple generations to recover.

Overall adverse effects on fish and shellfish from a VLOS in Cook Inlet could be **major**, depending on the timing and location of the spill and the environmental conditions at the time of the spill.

4.12.6. Marine Mammals

Much of what is known about the effects of a VLOS on marine mammals stems from studies associated with the Exxon Valdez Oil Spill in Prince William Sound, the *Selendang Ayu* spill in the Aleutian Islands, and the *Deepwater Horizon* spill in the Gulf of Mexico. Impacts to marine mammals from a hypothetical VLOS may include mortality, long-term sublethal impacts (e.g., decreased reproduction and survival rates over time), and impacts to healthy prey availability.

The life history, distribution, and abundances of marine mammals that occur in the proposed Lease Sale Area are discussed in Chapter 3. As described in Section 4.3.6 for accidental spills, impacts to marine mammals could result from direct exposure to oil and other contaminants, contamination and reduction of food sources, and displacement from and avoidance of habitat. Section 4.3.6 also provides species-specific impacts from spill events. Increased vessel and air traffic from oil spill response efforts may disrupt foraging, habitat use, daily or migratory movements, and behavior, and may also increase the risk of vessel strikes. Response activities, such as the use of booms and skimmers to contain and collect surface oil, may affect marine mammals through direct interaction and displacement from habitat. Oil spills also may alter the marine ecosystem and key features of marine mammal habitat, resulting in changes in habitat quality or prey availability (MMC, 2012).

During oil spill response, NMFS, the USFWS, and State officials would provide guidance for marine mammal response and monitoring activities. Specific marine mammal protection activities would be employed as required by the situation and would be modified as needed to accommodate changing conditions. Long-term recovery to pre-spill abundance, distribution, and productivity is likely, but the recovery period would vary and require access to unaffected or restored habitat.

The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on each group of marine mammals are described in the following sections.

4.12.6.1. Phase 1 (Initial Event)

4.12.6.1.1. Cetaceans

An explosion from a seafloor or within the water column blowout 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, possibly lead to declining health and mortality. Injury or mortality could occur in individuals within a very small radius of an underwater blowout event. Most cetaceans tend to avoid active drilling rigs and associated operations; therefore, it is unlikely that individuals would be close enough to an explosion to experience TTS or PTS. Cetaceans present at greater distances from the explosion could experience non-lethal and temporary effects of startle events (McCauley et al., 2000a,b), which may cause cetaceans to display short-term avoidance activity such as change of swim direction or speed that may be accompanied by short-term endocrine response. A fire on the drilling rig would likely have negligible effects on cetaceans because it is expected that the animals would be beyond the avoidance distances and would continue to avoid the immediate area of activity.

Sediment suspension and redistribution in the vicinity of the incident would have a negligible impact on cetaceans, owing to the relatively extensive habitat area available to cetaceans and the food sources that may be found or produced on or near the seafloor in Cook Inlet. Additionally, the extreme tidal exchange in Cook Inlet creates turbid water conditions to which marine mammals using the area have adapted. The localized nature of a sunken rig would have negligible impacts on cetaceans in terms of a hazard to movement or accidental contact with hazardous materials or structures. 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 seafloor, or be recovered. Additionally, the tidal fluctuations in Cook Inlet regularly cause changes in bathymetry, alterations of seafloor morphology, and deposition of debris, conditions through which cetaceans navigate. Thus, it is unlikely that the sinking of a rig would have any impacts on cetaceans.

4.12.6.1.2. Pinnipeds

An explosion at the drillsite could cause direct impacts (i.e., auditory, injury, or death) to 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 (SPL) and 144 dB re 20 µPa (2-s) (SEL). Pulsed noise levels exceeding these thresholds may elicit TTS or PTS in seals within the noise radius. 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 the main habitat range of fur seals and Steller sea lions occurs outside of the proposed Lease Sale Area in the Gulf of Alaska (Consiglieri et al., 1982; Loughlin et al., 1999; Merrick, Loughlin, and Calkins, 1987), few individuals from these species are expected to occur in close proximity to drilling. Therefore, few individuals are expected to be exposed to physiological damage due to an explosion or fire. Harbor seals are ubiquitous throughout Cook Inlet and may occur around drilling platforms, thus some individuals may be exposed to physiological damage during this phase.

4.12.6.1.3. Fissipeds

Phase 1 IPFs would likely cause only negligible, temporary, and non-lethal effects to most sea otters in the proposed Lease Sale Area, with the exception of individuals experiencing auditory injuries, bodily injuries, or mortality within a very small radius around an underwater blowout. An explosion at the drillsite could cause direct impacts (auditory, injury, or death) to sea otters in the immediate vicinity. Ciminello et al. (2012) determined in-water injury criteria for sea otters from impulsive noises to be 215 dB SEL for onset PTS, and 200 dB SEL for TTS. Pulsed noise levels exceeding these thresholds may elicit TTS or PTS in any sea otters within the noise radius stated above.

Ultimately, the amount of pressure and noise produced by an explosion would determine the extent of any danger zones for sea otters in the area. Such pressure and noise levels are highly variable, depending on a host of factors characterizing an explosion. As sea otters may occur within the proposed Lease Sale Area around drilling platforms, some sea otters may be exposed to harm from a fire. Sediment redistribution is expected to be localized, small in scale, and have negligible to minor effects on sea otters if it happens within their preferred environment.

4.12.6.2. Phase 2 (Offshore Spill)

Direct exposure to oil and gas is the critical IPF potentially affecting marine mammals during this phase. As described in detail in Section 4.3.6, marine mammals could experience effects from direct contact with hydrocarbons, including the following:

- Inhalation of liquid and gaseous toxic components of crude oil and gas

- Ingestion of oil and/or contaminated prey
- Fouling of baleen (fin, humpback, minke, blue, and gray whales) and oiling of fur (fur seals and sea otters); and
- Oiling of skin, eyes, and conjunctive membranes causing corneal ulcers, conjunctivitis, swollen nictitating membranes, and abrasions

Effects to pinnipeds from exposure to oil can include mortality, brain and liver lesions, skin irritation and conjunctivitis, increased PAH concentrations in blubber, increased petroleum-related aromatic compounds in bile, and abnormal behavior such as lethargy, disorientation, and unusual tameness (Frost, 1997; Loughlin et al., 1996; Spraker et al., 1994). Ingestion of hydrocarbons can irritate and destroy epithelial cells in the stomach and intestine of marine mammals, affecting motility, digestion, and absorption, which may result in death or reproductive failure (Geraci and St. Aubin, 1990). Direct ingestion of oil, ingestion of contaminated prey, and inhalation of volatile hydrocarbons transfer toxins to body fluids and tissues, causing effects that may lead to death, as suspected in dead gray and harbor seals found with oil in their stomachs (Engelhardt, 1987; Frost et al., 1994a,b; Geraci and St. Aubin, 1990; Jenssen, 1996; Spraker, Lowry, and Frost, 1994).

Inhalation of highly concentrated petroleum vapors can cause inflammation and damage to the mucous membranes of airways, lung congestion, hemorrhagic bronchopneumonia, and pulmonary edema in severe cases (Zieserl, 1979). After extreme exposure, asphyxiation may occur (Geraci and St. Aubin, 1982). Fur-bearing species (i.e., sea otters and fur seals) that have oil adhering to their body surfaces could be exposed to toxic fumes for prolonged periods of time. Marine mammals that exhibit extensive grooming behavior, such as sea otters, are likely to inhale oil vapors while attempting to clean their fur of the oil. Emphysema and lung congestion from the inhalation and aspiration of toxic hydrocarbons were among the primary factors in the death of sea otters contacted by the Exxon Valdez Oil Spill (Geraci and Williams, 1990). Sea otters and fur seals are particularly vulnerable to oil contamination because they rely on pelage rather than blubber for insulation, and oiling drastically reduces the insulating value of the fur (Costa and Kooyman, 1982; Geraci and Williams, 1990; Mearns et al., 1999; Siniff et al., 1982).

4.12.6.2.1. Cetaceans

Release of oil into offshore and nearshore waters during this phase has the greatest potential to affect cetaceans and their habitats. Potential IPFs associated with Phase 2 that could affect cetaceans include contact with oil, contamination, and loss of access (disturbance and displacement).

Cetaceans are obligatory surface breathers and the large quantities of monoaromatic hydrocarbons evaporating out of an oil slick would be most concentrated immediately above the water's surface (Matkin et al., 2008). Monoaromatics easily cross membranes in the lungs and will be taken up rapidly, resulting in a narcosis response well documented in humans (Ainsworth, 1960; Bass, 1986). Griffiths et al. (1987) described the deaths of seven dolphins caused by respiratory stress due to oil inhalation after a spill in the Arabian Sea. The fumes themselves may not have been directly lethal, but they could easily have caused marine mammals to lose consciousness and drown (St. Aubin and Geraci, 1994).

The effects of vapor or oil inhalation may range from instant death to sublethal damage to mild irritation, depending on concentration and length of exposure (Geraci, 1990). If there were acute mortalities, then sublethal damage should be prevalent as well. Inhaled hydrocarbons may inflame mucous membranes, cause lung congestion, lead to pneumonia, and cause neurological damage and liver disorders (Geraci, 1990; Lipscomb et al., 1994; Neff, 1990). While the most acutely toxic compounds in crude oil volatize first, lethal effects may be experienced during the first month after a spill (Spies et al., 1996).

Potential impacts from contamination on cetaceans may include ingestion of contaminated prey and reduction of food sources. Pollution stemming from an oil spill may contaminate the environment, habitat, and food sources. Contamination may also cause mortality and or contamination of food sources during the long term (i.e., multi-year) and short term (i.e., current year production, ice and oceanographic cycles).

Cetaceans may be displaced from feeding areas, migration routes, and critical life function habitats as a result of an offshore oil spill. Certain life function areas are critical to the maintenance of individuals and populations, including birthing, feeding, breeding, migration, rearing/nursing, and resting. Loss of access to these areas could have adverse effects on marine mammals.

4.12.6.2.2. Pinnipeds

Harbor seals, fur seals, and Steller sea lions may be exposed to hydrocarbons during a VLOS event, and suffer direct and indirect impacts as discussed previously. The vulnerability of individual pinniped species to contacting crude oil is largely a function of their seasonal use of different areas. Some coastal use areas, including rookeries, haul-outs, and aquatic foraging areas are the most likely areas for relatively larger numbers of pinnipeds to come in contact with spilled oil.

Sea lions exposed to oil spills may become contaminated with PAHs through inhalation, dermal contact and absorption, direct ingestion, or ingestion of contaminated prey (Albers, 2003). After the Exxon Valdez Oil Spill, Calkins et al. (1994) recovered 12 Steller sea lion carcasses from the beaches of Prince William Sound and collected 16 additional Steller sea lions from haul-out sites in the vicinity of Prince William Sound, the Kenai coast, and the Barren Islands. The highest levels of PAHs were in animals found dead following the oil spill in Prince William Sound. Furthermore, sea lion bile samples collected 7 months after the spill had levels of PAH metabolites consistent with exposure to PAHs (Calkins et al., 1994). However, histological examinations found no lesions that could be attributed to hydrocarbon contamination and, hence, no evidence of damage due to oil toxicity (Calkins et al., 1994). Sea lions did not seem to avoid oil during the Exxon Valdez Oil Spill (Calkins et al., 1994). The animals were sighted swimming in or near oil slicks; oil was seen near numerous haul-out sites; and oil fouled the rookeries at Seal Rocks and Sugarloaf Island. Oil did not persist on sea lions as it did with harbor seals (Calkins et al., 1994). Insignificant amounts of oil were seen at each site during pup counts in late June 1989, but none were seen in 1990. Critical habitat for Steller sea lions, including numerous haul-outs, several rookeries (Sugarloaf and Marmot Islands), and the aquatic foraging area throughout Shelikof Strait could be contacted by a VLOS (see Section 4.12.6.6 for discussion of OSRA results).

As described in Section 4.3.6, harbor seals showed no avoidance of oil following the Exxon Valdez Oil Spill, swimming in oiled water and surfacing in oil slicks to breathe at the air-water interface where volatile hydrocarbon vapors were present (Frost et al., 1994a,b). Through spring and summer, seals crawled over and rested on oiled rocks and algae at haul-outs. Harbor seals inhabiting central Prince William Sound, including Eleanor Island, the north part of Knight Island, and the west side of Knight Island Passage, became heavily coated with oil. More than 80% of the seals observed in these areas in May 1989 had oil on them (Frost, 1997). Many seals remained oiled until their annual molt in August (Frost et al., 1994a,b). Some of the haul-out sites remained oiled through the May/June pupping season, and many pups became oiled shortly after birth (Frost, 1997). In the Bay of Isles and Herring Bay on the north end of Knight Island, 89% to 100% of all seal pups seen were oiled (Lowry, Frost, and Pitcher, 1994). Studies in Prince William Sound showed that harbor seals were temporarily displaced from oiled haul-outs but returned to previously oiled habitats the following year at the same rate as unoiled sites (Frost et al., 1994a,b; Frost, Lowry, and Ver Hoef, 1999). By 1990, there was no longer any difference in the rate of decline between oiled and unoiled sites, and it was concluded that the effects of the oil spill were evident only in population declines of 1989 (Frost et al., 1994a,b). A further analysis of harbor seal population trends and movements in Prince William Sound suggested harbor seals moved away from some oiled haul-outs during the Exxon Valdez Oil Spill (Hoover-Miller et al., 2001) and the original estimate of 300+ harbor seal mortalities may have been overstated. Long-term impacts to harbor seals from a VLOS are not expected. Adjusted counts from Frost's surveys between 1989 and 1997 showed significant population declines (4.6%), but this may be attributed to a decline that began before the oil spill. Subsequently, the number of seals in the Kodiak Archipelago has been increasing and may be stabilizing from the declines of the previous decades (Blundell et al., 2005; Small et al., 2003). In Prince William Sound, indirect effects of oil on harbor seals via exposure to nearshore food resources was considered negligible due to the low likelihood of contamination in prey, combined with large feeding areas relative to the extent of lingering oil (Integral Consulting, 2006).

Pinnipeds that exhibit extensive grooming behavior, such fur seals, are likely to inhale oil vapors while attempting to clean their fur of the oil. Fur seals likely would also suffer direct mortality from oiling through a reduced thermoinsulative capacity that would result in hypothermia (Reed et al., 1987; Reiter, 1981). Because the main habitat range of fur seals occurs outside of the proposed Lease Sale Area (Consiglieri et al., 1982; Loughlin et al., 1999; Merrick, Loughlin, and Calkins, 1987), their exposure to oil would likely be limited to the oil that reached the Gulf of Alaska.

Changes in prey resources due to a VLOS could have adverse effects on pinnipeds. Harbor seals, Steller sea lions, and fur seals share much of the same prey base. Harbor seals are opportunistic feeders whose diet varies with season and location. In the Gulf of Alaska, Pitcher and Calkins (1979) found that fish (e.g., Pollock, capelin) made up 74.3% of total prey volume for harbor seals; cephalopods, 21.7%; and decapod crustaceans, 4.0%. Scat analysis from Kodiak harbor seals showed Irish lords (43%) and sand lances (25%) were predominate prey items (Jemison, 2001). Steller sea lion stomach content analysis in the mid-1970s and mid-1980s (Calkins and Goodwin, 1988; Pitcher, 1981) found walleye pollock was the principal prey with octopus, squid, herring, Pacific cod, flatfishes, capelin, and sand lance also being consumed frequently. These and additional studies (Calkins, 1998; Merrick and Calkins, 1996) showed that overall, small forage fish and salmon were almost exclusively eaten during the summer, while cephalopods and other fishes were eaten more frequently in the spring and fall. Fur seals tend to congregate in areas over the OCS and slope where nutrient upwelling results in an abundance of various schooling fishes such as capelin, sand lance, pollock, and herring as well as invertebrates such as squid, on which the seals feed (Lowry, Frost, and Loughlin, 1989; Perez and Bigg, 1986). 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 decline in Steller sea lions has been linked to reductions in prey biomass and quality, resulting in nutritional stress that subsequently decreased vital rates (Kucey and Trites, 2006). Depending on the extent of the reduction in quantity and quality of prey species, the consequences of such a loss in the prey base could be decreased rates of reproduction or survivorship by reducing individual condition or fitness, or displacement from their habitats due to loss of prey availability.

4.12.6.2.3. Fissipeds

As described in Section 4.3.6, much of what is known about the effects of oil on sea otters stems from research following the 1989 Exxon Valdez Oil Spill in Prince William Sound. Acute effects of the Exxon Valdez Oil Spill included the documented mortality of nearly 1,000 sea otters, with total acute deaths estimated to be as high as several thousand (Ballachey, Bodkin, and DeGange, 1994). Acute oil exposure in sea otters resulted in lung, liver, and kidney damage (Lipscomb et al., 1993, 1994). Changes in serum enzymes associated with liver damage were documented in wild sea otters in 1992, and again, although to a lesser extent, in 1996 to 1998 (Ballachey et al., 2002, 2003), suggesting that sea otters many years after the spill may have experienced pathologies similar to those seen in animals dying shortly after the spill. As documented by Short et al. (2004, 2006) and Li and Boufadel (2010), oil has persisted on shorelines and presented a continuing risk of exposure to animals utilizing nearshore areas (Bodkin et al., 2012) for at least two decades.

Indirect chronic effects to sea otters from a VLOS may be caused by (1) sublethal initial exposure to oil causing pathological damage to the otters; (2) continued exposure to hydrocarbons persisting in the environment, directly or indirectly through ingestion of contaminated prey; and (3) altered availability of sea otter prey as a result of the spill (Ballachey et al., 1994).

Chronic effects to sea otters from exposure to oil have been shown to affect mortality patterns, abundance, and survival rates. By late 1991, three findings indicated that chronic damages were limiting recovery of the sea otter population in Prince William Sound: (1) patterns of mortality were abnormal when compared to pre-spill data (Monson, 1994), (2) surveys showed no increase in abundance (Burn, 1994), and (3) juvenile survival was low in oiled areas of western Prince William Sound (Rotterman and Monnett, 1991).

Possible mechanisms for prolonged oil-related injury to sea otters were substantiated by several studies. Pathologies of the liver and kidney were observed in oiled sea otters recovered dead (Lipscomb et al., 1994), and it is reasonable to assume that similar pathological changes may have occurred in sea otters that were exposed to oil and survived. Residual oil persisted in intertidal (Roberts et al., 1993) and subtidal (O'Clair, Short, and Rice, 1993) areas of Prince William Sound, providing the potential for continued direct exposure of sea otters to oil and possible ingestion through grooming. In addition, particularly high concentrations of oil were found in mussel beds 2 and 3 years after the spill (Babcock et al., 1993). Because mussels are common prey for sea otters, particularly juveniles, the contaminated mussel beds may have been a source of continued indirect exposure to oil.

The foraging success of sea otters did not appear to be affected by the Exxon Valdez Oil Spill. The level of contamination in prey may depend on where the prey is located (e.g., subtidal versus intertidal), and the effects of prey contamination on sea otters may depend on the age class preferences for different prey types (e.g., juvenile sea otters preferring to forage in contaminated intertidal zones that would be more contaminated than subtidal zones in which adult sea otters prefer to forage).

Studies after the Exxon Valdez Oil Spill showed that the foraging success of sea otters (in terms of the percentage of successful dives or the mean number of prey items captured per dive) was not affected in the oiled area 2 years after the Exxon Valdez Oil Spill (Doroff and Bodkin, 1994). Prey composition (i.e., clam, mussel, and crab) was similar among oiled and non-oiled study sites and to pre-spill data from western Prince William Sound. Tissues of subtidal bivalve prey tested for hydrocarbon content did not differ, regardless of the degree of shoreline oiling. Mussel tissue sampled between 1989 and 1992 from the intertidal areas exhibited hydrocarbon concentrations similar to crude oil in some areas (Babcock et al., 1993). Contamination of mussels and other intertidal prey species may be of concern for juvenile sea otters and for adults focused on the consumption of intertidal prey.

Large-scale mortality and displacement of sea otters could occur as a result of a VLOS, as documented in Prince William Sound following the Exxon Valdez Oil Spill. Based on comparisons of pre-spill and summer 1989 survey data from Prince William Sound, the 35% decline in shoreline sea otter density within the oiled area suggested a significant first-year effect of the oil spill on the Prince William Sound sea otter population (Burn, 1994). Further declines in shoreline sea otter density in oiled areas of Prince William Sound between 1989 and 1990 suggested a continuing impact from the oil. However, this decline was mirrored by a decline in shoreline sea otter density within unoiled areas of Prince William Sound, leading Burn (1994) to suggest the possibility of a sound-wide decline in the sea otter population between the summers of 1989 and 1990. Abundance estimates of all survey strata combined for July 1989 and July 1990 were not markedly different between oiled and unoiled areas.

4.12.6.3. Phase 3 (Onshore Contact)

Cetaceans are unlikely to be affected by onshore contact of oil, because the life history of these animals does not depend on any onshore resources. Harbor seals, Steller sea lions, fur seals, and sea otters would be affected by oil that contacts shorelines serving as haul-outs and rookeries, with adverse effects of oil contamination occurring as described in Phase 2. Onshore contact with oil may increase the extent and duration of oiling (and so increase the incidence or severity of subsequent effects from oiling, as previously described) to these species given that they spend large amounts of time, in large numbers (excepting sea otters), and in close contact to each other in haul-outs and rookeries. Onshore oil was observed at haul-outs for months following the Exxon Valdez Oil Spill, although surveys in subsequent years showed most haul-outs were no longer visibly oiled (Calkins et al., 1994; Frost et al., 1994a, b). Fur seal pups are extremely vulnerable to onshore oil contamination, and significant mortality may be expected (Mearns et al., 1999).

Oiled shorelines are not likely to cause loss of access to habitat for pinnipeds because these species have shown little avoidance to oil (Calkins et al. 1994; Frost et al. 1994a,b; Loughlin et al. 1995). Harbor seals showed significant displacement from some oiled haul-out areas in 1989 (Frost et al., 1994a,b), but subsequent surveys showed no long-term displacement (Frost, Lowry, and Ver Hoef, 1999). Loss of access to habitat may occur over time if the quantity and quality of prey is reduced in nearshore foraging area, as is discussed in Phase 2. Sea otters will likely be affected by spills contacting coastlines and suffer the same effects as described in Phase 2. During nine surveys after the Exxon Valdez Oil Spill, a total of 2,639 transects were sampled, with 4,791 sea otter sightings totaling 6,469 individuals. The majority of sea otters counted, 92% (5,975), were within the shoreline stratum (Burn, 1994). Onshore contact with oil may increase the extent and duration of oiling (and so increase the incidence or severity of subsequent effects from oiling, as previously described) to sea otters given that they spend some amount of time on and near the shoreline.

4.12.6.4. Phase 4 (Spill Response and Cleanup)

Oil spill response, cleanup, restoration, and remediation activities could adversely affect marine mammals and their habitats in Cook Inlet and the surrounding region. The potential IPFs during this phase include 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; and
- Bioremediation activities, including short- and long-term monitoring and research studies to evaluate effectiveness of cleanup actions

The potential impacts of vessel activity, aircraft, drilling, physical presence, and other IPFs were described in Section 4.3.6. In most cases, impacts from noise and disturbance (including collisions) from vessels, aircraft, drilling, and discharges as well as physical presence of activity are as described previously for these species, and are not repeated in the following sections. Briefly, increased vessel and air traffic may disrupt foraging, habitat use, daily or migratory movements, and behavior (e.g., breathing and resting patterns) (Constantine, Brunton, and Dennis, 2004; Lusseau et al., 2009; Nowacek, Wells, and Solow, 2001; Stensland and Berggren, 2007; Williams, Lusseau, and Hammond, 2006). Increased vessel traffic also increases the risk of vessel strikes (Bechdel et al., 2009; Laist et al., 2001).

The effects of dispersants on marine mammals are not well understood. An assessment of the physiological effects of oil and chemical dispersants on marine mammals was a priority recommendation to NMFS from the MMC (2012) following the *Deepwater Horizon* spill. In addition to potential effects of dispersants on marine mammals, there may be some adverse consequences of certain types of dispersants, which may affect the food web, and so indirectly affect marine mammals. Some response activities such as *in situ* burning and animal rescue could also have additive effects, in some cases displacing marine mammals to an even greater degree than the oil spill itself. Potential impacts to cetaceans, pinnipeds, and fissipeds from these activities are discussed in the following sections.

4.12.6.4.1. Cetaceans

The effects of vessel and aircraft traffic associated with an oil spill response may displace whales, as discussed in Section 4.3.6. Spill response techniques such as *in situ* burning, booming, and dispersants could affect cetaceans in the area. The noise from these activities would likely be masked by the noise emanating from the relief drilling effort, which whales could avoid as described in Section 4.3.6. There also would be monitors ensuring that marine species would not be in the vicinity of the burning.

Mysticete rescue actions are not anticipated; however, rescue efforts for some other species may bring small vessels into the vicinity of mysticetes. Negligible effects are anticipated from vessels as whales would likely avoid the activity. Rehabilitation and treatment facilities would be land-based and not practical for large whales. Disposal of contaminated carcasses and tissues as well as oil-contaminated materials such as absorbent pads and gloves would likely be at an authorized disposal site onshore. Negligible effects are anticipated. Rehabilitation of small numbers of beluga whales and other small whales is possible at the Alaska SeaLife Center. Rehabilitation and care standards could minimize impacts to rehabilitated individuals. Odontocete rescue actions are not likely to occur in upper Cook Inlet, given the extreme tidal fluctuations of Cook Inlet. Given capacity at a local rehabilitation facility and favorable capture conditions for beluga whales that meet capture criteria, rescue efforts may be attempted in lower Cook Inlet for very small numbers of beluga whales. Because rescue activities (including boat noise and the presence of humans) would likely cause stress to captured individuals (and potentially those in the vicinity), it is unlikely that the rescue of beluga whales would be undertaken unless the potential benefits outweighed the potential impacts. It is also unlikely that the capture of free-swimming cetaceans would be undertaken, although hazing may be proposed to deter them from oiled areas. Hazing may cause temporary effects such as the intended displacement; however, long-term effects from hazing would not be expected.

4.12.6.4.2. Pinnipeds

The effects of vessel and aircraft traffic associated with an oil spill response may displace seals as discussed in Section 4.3.6. Some activities such as *in situ* burning, animal rescue, the use of skimmers and booms, and drilling a relief well could have additive effects, the most likely of which would be the displacement of seals to an even greater degree than the oil itself. PSOs would likely be used on vessels and should reduce the number of seals that could be displaced around the response area. NMFS has established capture and rehabilitation criteria for oiled pinnipeds (Johnson and Ziccardi, 2006) that precludes actions likely to result in more harm than benefits to individuals and groups of animals. Hazing seals from oiled areas could preclude more severe impacts.

4.12.6.4.3. Fissipeds

Sea otters released from the rehabilitation centers after the Exxon Valdez Oil Spill in the summer of 1989 and monitored until the summer of 1991 exhibited relatively low survival and reproduction rates (Monnett and Rotterman, 1992; Monnett et al., 1990). Interpretation of these results is complicated by the inability to differentiate effects of oil exposure, treatment, prolonged captivity, and translocation (i.e., animals were not released in the areas where they had originally been captured) on the sea otters. Although rehabilitated sea otters may not be representative of the larger sea otter population, the relatively low reproduction and survival rates indicate potential long-term damages may result from oil exposure, rehabilitation, and/or translocation.

4.12.6.5. Phase 5 (Post-Spill, Long-Term Recovery)

Studies of exposure of marine mammals from two VLOS events (the *Deepwater Horizon* spill in the Gulf of Mexico in 2010 and the Exxon Valdez Oil Spill in Prince William Sound in 1989) have revealed long-term adverse effects on some cetacean species. Exposure to oil from the Exxon Valdez Oil Spill had a long-term effect on marine mammals, 15 years or more after the spill (Ballachey et al., 2007; Matkin et al., 2008). Long-term wildlife studies after that spill revealed chronic, delayed, and indirect effects that were longer and more severe than previously expected or assumed (Peterson et al., 2003). Long-term effects from a VLOS are a reasonable concern for marine mammals in Cook Inlet and the surrounding region.

4.12.6.5.1. Cetaceans

Known long-term impacts from accidental spills are discussed in Section 4.3.6, though there is a paucity of information for some cetacean species that could be affected by a VLOS. Many offshore species, deep-diving whales in particular, and a few less common mysticetes have not been monitored in a manner allowing direct conclusions regarding long-term effects and recovery. Often it is the scarcity of a species, or the difficulty in studying living specimens of that species that prevents analysts from forming direct conclusions relating to VLOS effects to that species. Frequently, observations have been made on anatomically or biologically similar species, and the data from such observations is frequently used as a proxy for analysts to conduct accurate, and sound effects analyses.

For instance, few studies have been conducted on North Pacific right whales, mainly because of their low population size which is believed to be around 30 individuals, and none analyzing the effects of a VLOS on them in Alaskan waters. However, right whales also exist in the North Atlantic, southern reaches of the South Pacific, and along the Asian coastline from Siberia, to the Koreas and Japan. The anatomical and behavioral similarities of these species/stocks would certainly permit regulatory biologists to apply results from those studies to North Pacific right whales.

However, for some species, such as the fin whale, gray whales, humpback whales, beluga whales, etc., there is a substantial amount of anecdotal, historical, and scientific information that permits effects analyses on other, less studied species due to anatomical, behavioral, and other biological similarities between cetacean species. Though species such as beaked whales, sei whales, etc. have rarely or never been observed interacting with oil spills, oil spill effects analysis on other anatomically, behaviorally, or biologically similar species such as porpoises, killer whales, gray whales, humpback whales, etc., permits a scientifically sound analysis.

The likely long-term impacts of a VLOS on cetaceans would be similar to what occurred in the years following the 1989 Exxon Valdez Oil Spill. Though there were a few likely mortalities initially, the populations have remained mostly unaffected by the incident, as evidenced by stock estimates provided by NMFS. In the aftermath of a VLOS there would be a general avoidance of the spill area until prey species returned to the area in sufficient abundance to support marine a cetacean species. The mobility of cetaceans and the long migration routes for many of them preclude long-term adverse population effects to their stocks; however some localized species such as the Cook Inlet beluga whale would likely experience major levels of effect from a VLOS, through the physiological effects of oiling inside Cook Inlet, and the long-term effects to their prey base, notably anadromous fishes, hooligan, herring, etc.

4.12.6.5.2. Pinnipeds

A VLOS could cause long-term impacts to fur seals, harbor seals, and Steller sea lions; however, many of the effects of a VLOS on these species are anticipated to be temporary and localized to the spill area. Large mortality events have been associated with VLOSs for both harbor seals (Frost et al., 1994a,b) and fur seals (Mearns et al., 1999; Reiter, 1981). The mortality of harbor seals numbered in the hundreds during the first year after the Exxon Valdez Oil Spill, but subsequent surveys showed no long-term impacts to their abundance (Frost et al., 1994a, b; Frost, Lowry, and Ver Hoef, 1999; Small et al., 2005). "Many" (Reiter, 1981) to thousands (Mearns et al., 1999) of fur seals have suffered mortality due to oiling events, but an understanding of the long-term impacts from these oiling events has not been published.

All three pinniped species may suffer long-term impacts if their prey species are substantially reduced in quantity or quality and do not recover to sufficient levels to maintain the fitness of these populations, as has been shown for Steller sea lions (Kucey and Trites, 2006). In the event of a VLOS, harbor seals, fur seals, and Steller sea lions could be adversely affected to varying degrees depending on habitat use, densities, season, and various spill characteristics. Much of the effects would depend on the timing of the spill. If a VLOS occurred during winter months, many of the harbor seals would be feeding in Sheilikof Strait, as would many of the sea lions, while the fur seals would be mostly feeding near the continental shelf break and in Sheilikof Strait. During summer most fur seals would be in the Bering Sea, while harbor seals would be dispersed throughout Cook Inlet and Steller sea lions would be dispersed in the southern portion of the lower inlet and near rookeries and haulouts along the Gulf of Alaska.

4.12.6.5.3. Fissipeds

A VLOS could cause long-term impacts to sea otters. The mortality of sea otters numbered in the thousands during the first year after the Exxon Valdez Oil Spill, and spill-related mortalities continued for several years. The Prince William Sound population of sea otters was not considered fully recovered from the oil spill until 2014, 25 years after the spill occurred (Ballachey et al., 2014). As discussed previously, chronic effects to sea otters from exposure to oil have been shown to affect mortality patterns, abundance, and survival. Sea otters may also suffer long-term impacts if their prey species are substantially reduced in quantity or quality and do not recover to sufficient levels to maintain the fitness of these populations.

4.12.6.6. Oil-spill Risk Analysis

Marine mammals in the proposed Lease Sale Area are represented in the OSRA model by ERAs listed in Tables A.1-8 to A.1-10 of Appendix A, respectively. As stated in Section 4.3.6.8, it is important to note that ERAs represent areas of social, economic, or biologic importance designated by BOEM analysts in the Alaska OCS region (see Appendix A). ERAs are assigned to species for which there is sufficient information to confidently identify the area as important to that species, usually during specific seasons. Other species or groups may be present in ERAs and potentially affected by an oil spill.

A summary of the highest percentage of VLOS trajectories originating from LAs and contacting resources for whales, seals and sea lions, and sea otters within 110 days during summer and winter is provided in Tables 4.12.6-1 through 4.12.6-3, respectively. In this analysis, VLOS trajectories with ≤5% trajectories contacting resources likely would be widely dispersed and weathered, and not estimated to produce appreciable impacts on cetaceans based on the spill assumptions in Appendix A, Section A-3.2, and thus will not be discussed in detail.

Table 4.12.6-1. Highest Percentage of VLOS Trajectories Contacting Whale Resources[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer	Winter
		110 days[2]	110 days
Environmental Resource Area (ERA)	≥0.5–<6	27, 28, 30, 70, 73, 78, 84, 85, 86, 87, 89, 91, 92, 97, 99, 109	16, 26, 27, 28, 30, 70, 76, 78, 89, 91, 94, 97, 99, 109
	≥6–<25	16, 24, 25, 26, 76, 77, 81, 82, 83, 94, 95, 98, 101, 108	24, 25, 75, 77, 95, 98, 108
	≥25–<50	71, 75, 80, 90, 102, 103, 105	71, 80, 90
	≥50	72, 104	72

Notes: [1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) are the same as the highest percentage of trajectories in 110 days in both seasons, but the individual results from each LA may not be identical.

Source: Appendix A (Tables A.1-8, A.2-25, and A.2-45). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

Table 4.12.6-2. Highest Percentage of VLOS Trajectories Contacting Seal and Sea Lion Resources[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer	Winter
		110 days[2]	110 days
Environmental Resource Area (ERA)	≥0.5–<6	21, 27, 28, 29, 30, 31, 32, 37, 38, 43	16, 20, 26, 27, 28, 29, 30, 31, 37, 43
	≥6–<25	16, 19, 20, 23, 24, 25, 26	19, 23, 24, 25
	≥25–<50	15, 18	15, 17, 18
	≥50	11, 12, 13, 14, 17	11, 12, 13, 14

Notes: [1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) is the same as 110 days in both seasons, but the individual results from each LA may not be identical.
Source: Appendix A (Tables A.1-9, A.2-25, and A.2-45). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

Table 4.12.6-3. Highest Percentage of VLOS Trajectories Contacting Sea Otter Resources[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer	Winter
		110 days[2]	110 days
Environmental Resource Area (ERA)	≥0.5–<6	50, 51, 59, 60, 65, 66	16, 50, 57, 59, 60, 65
	≥6–<25	16, 45, 49, 64, 67, 68	49, 64, 67, 68
	≥25–<50	--	45, 46
	≥50	46, 47, 48	47, 48
Land Segment (LS)	≥0.5–<6	84, 86, 87	84, 86, 87
	≥6–<25	35	35
Grouped Land Segment (GLS)	≥0.5–<6	124, 152, 159	124, 152, 159
	≥6–<25	141	141

Notes: -- all percent chances of contact are <0.5.
[1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) is the same as 110 days in both seasons, but the individual results from each LA may not be identical.
Source: Appendix A (Tables A.1-10, A.2-25, A.2-30, A.2-35, A.2-45, A.2-50, and A.2-55). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

4.12.6.6.1. Cetaceans

A hypothetical VLOS could contact offshore areas when and where ESA-listed and non-ESA-listed cetaceans may be present. The location, timing, and magnitude of a VLOS and the concurrent seasonal distribution and movement of cetaceans would determine the degree of contact with oil. This section describes the results estimated by the OSRA model for a hypothetical VLOS originating within six LAs in the proposed Lease Sale Area contacting specific ERAs defined for cetaceans, as described in Section 4.3 and detailed in Appendix A (specifically Table A.1-8). The dynamics of oceanographic, climatic, and biotic factors affecting the distribution and abundance of prey, timing of accessibility to habitats, and corridors for movement will be factors that determine the location and magnitude of cetaceans and oil to come into contact. The percent of trajectories contacting an ERA does not imply that the entire ERA will be affected. The location of contact to the ERA is not provided by the OSRA model. Potential areas of species-specific contact with oil are described in the following subsections.

Cook Inlet Beluga Whale

The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter) beluga whale ERAs in Cook Inlet and the surrounding region (ERAs 16 and 69 to 72) is as follows (with references to relevant maps and tables in Appendix A):

- ≥50% – ERA 72, West Cook Inlet Beluga Critical Habitat (Map A-2b);
- ≥25% to <50% – ERA 71, Middle Cook Inlet Beluga Critical Habitat (Map A-2b);
- ≥6% to <25% – ERA 16, Inner Kachemak Bay (in summer only) (Map A-2b); and
- ≥0.5% to <6% – ERA 70, Forelands Beluga Critical Habitat (Map A-2a); ERA 16, Inner Kachemak Bay (in winter only) (Mab A-2b).

Cook Inlet beluga whales are vulnerable in these ERAs year-round (Appendix A, Table A.1-8). ERAs 70 to 72 occur in Cook Inlet beluga whale Critical Habitat Area 2, an area designated as important for fall and winter feeding and transit (76 *FR* 20180, April 11, 2011). ERA 72 is in the far southern extent of the Cook Inlet beluga whale range and has the highest percent of trajectories contacting (≥50%). Beluga whales would be less likely to occur in ERA 72 in the summer months in any great numbers; however, this area has been determined to be an important feeding and transit area during the fall and winter. ERAs 71 and 70 both occur in the mid-Inlet, an area that beluga whales are known to use throughout the year, although they generally concentrate in upper Cook Inlet during summer. Additionally, these ERAs occur in areas considered to be year-round Small and Resident Population BIAs for beluga whales (Ferguson, Curtis, and Harrison, 2015). As the Cook Inlet beluga whale population is small and residential to Cook Inlet, any impact from direct or indirect effects from a VLOS could have severe population-level impacts. ERA 69 (Upper Cook Inlet; Appendix A, Map A-2a) is also important habitat for beluga whales, but that area has <0.5% trajectories contacting.

Killer Whale

The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter) killer whale ERAs in Cook Inlet and the surrounding region (ERAs 41, 108, 109) is as follows (with references to relevant maps and tables in Appendix A):

- ≥6% to <25% – ERA 108, Shelikof Killer Whale (Map A-2e); and
- ≥0.5% to <6% – ERA 109, East Kodiak Killer Whale (Map A-2e).

Killer whales are deemed vulnerable in these areas year-round. ERAs 108 and 109 are located around Kodiak Island, an area commonly used by killer whale stocks in the region, notably in summer months, but they have been observed here year-round. ERA 41 (Resurrection/Chiswell; Appendix A, Map A-2c) is also important habitat for killer whales but is not estimated to be contacted.

Fin Whale

The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter unless otherwise noted) fin whale ERAs in Cook Inlet and the surrounding region (ERAs 24 to 28, 30, 89 to 91) is as follows (with references to relevant maps and tables in Appendix A):

- ≥25% to <50% – ERA 90, Barren Islands (Map A-2f);
- ≥6% to <25% – ERAs 24 and 25, Shelikof MM2 and 3 (Map A-2d); and
- ≥0.5% to <6%) – ERAs 26 to 28, 30, Shelikof MM4 to 6, 8 (in summer and/or winter) (Map A-2d); ERA 89, Shelikof MM11 (Map A-2h); ERA 91, NE Kodiak Fin Whale (Map A-2f).

These ERAs occur around Kodiak Island and the Shelikof Strait, areas deemed feeding BIAs for fin whales (Ferguson, Curtis, and Harrison, 2015). The highest densities of fin whales in this area occur from June through August, although they may be observed year-round by aerial and acoustic surveys (Clapham et al., 2012; Moore et al., 2006; Stafford et al., 2007; Witteveen, pers. comm., 12 January 2015, as cited in Ferguson, Curtis, and Harrison, 2015). Fin whales are deemed vulnerable in these areas year-round.

Gray Whale

Gray whales are deemed vulnerable in ERAs 93 to 99 from April to December, in ERA 92 from June to August, and in ERA 100 from October to December (Appendix A, Table A.1-8). The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter unless otherwise noted) gray whale ERAs is as follows (with references to relevant maps and tables in Appendix A):

- ≥6% to <25% – ERA 94, Lower E Kenai Gray Whale (in summer only) (Map A-2c); ERA 95, NE Kodiak Gray Whale (Map A-2g); and ERA 98, Shelikof Gray Whale (Map A-2g); and
- ≥0.5% to <6%) – ERA 92, Kodiak Gray Whale Feeding (in summer only) (Map A-2g); ERA 94, Lower E Kenai Gray Whale (in winter only) (Map A-2c); ERA 97, SE Kodiak Gray Whale (Map A-2f); ERA 99, N Shumagin Gray Whale (Map A-2h).

The OSRA model estimates ERAs 93, 96, and 100 have <0.5% of VLOS trajectories contacting them and are unlikely to be impacted. All of these ERAs occur around Kodiak Island and adjacent to the Alaska Peninsula, areas deemed migratory BIAs for gray whales (Ferguson, Curtis, and Harrison, 2015). As the highest densities of gray whales in these migratory BIAs occur from November to January (when whales are southbound), and from March to May when whales are northbound (Braham, 1984a,b; Rugh, 1984; Rugh et al., 2001), gray whales would have a higher risk of exposure to oil if a VLOS occurred during these times. Additionally, ERAs 95 and 98 occur in gray whale feeding BIAs (Ferguson, Curtis, and Harrison, 2015); as the greatest densities of whales in these BIAs occur from June to August (Moore et al., 2007; Witteveen, pers. comm., 12 January 2015, as cited in Ferguson, Curtis, and Harrison, 2015; Wynne and Witteveen, 2005, 2013), gray whales would be at increased risk of exposure to oil during a VLOS occurring in this time period.

Humpback Whale

The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter unless otherwise noted) humpback whale ERAs in Cook Inlet and the surrounding region (ERAs 75 to 79; Appendix A, Table A.1-8) is as follows (with references to relevant maps and tables in Appendix A):

- ≥25% to <50% – ERA 75, Kachemak Humpback Whale (in summer only) (Map A-2c);
- ≥6% to <25% – ERA 75, Kachemak Humpback Whale (in winter only) (Map A-2c); ERA 76, Shelikof Humpback Whale (in summer only) (Map A-2f); ERA 77, North Kodiak Humpback Whale (Map A-2c); and
- ≥0.5% to <6% – ERA 76, Shelikof Humpback Whale (in winter only) (Map A-2f); ERA 78, E Kodiak Humpback Whale (Map A-2f).

The OSRA model estimates ERA 79 (South Kodiak Humpback Whale; Appendix A, Map A-2f) has <0.5% of VLOS trajectories contacting it and is unlikely to be impacted. Humpback whales are deemed vulnerable in these areas from May to December. Three of the ERAs (76 to 78) occur around the Kodiak Island in a feeding BIA for humpback whales (Ferguson, Curtis, and Harrison, 2015). The highest densities of humpback whales in this BIA occur from July through September (Witteveen et al., 2007, 2011). The fourth (ERA 75, Kachemak) occurs just north of the BIA, on the southern extent of the Kenai Peninsula, another area of high use by humpback whales in the summer. Humpback whales would be most immediately impacted in these areas from a VLOS in the summer and fall, although there may be additional impacts from long-term oil exposure in the areas from contaminated environment and prey species.

From the available data, it is difficult to determine whether the Exxon Valdez Oil Spill had any measureable impact on the number of humpback whales occurring in Prince William Sound (Von Ziegesar, Miller, and Dahlheim, 1994). The greatest number of humpback whales ever reported in Prince William Sound (by 1994) occurred in 1989 and 1990, including 59 and 66 identified individuals, respectively; however, the number of whales identified per day and mile was much lower than in 1988.

This may be the result of surveying a much larger portion of Prince William Sound, including low-density areas of humpback whales. The redistribution of whales in Lower Knight Island Passage in late June and July 1989 was temporary and may have been prey related. In 1990, whales were once again noted in Lower Knight Island Passage area. In 1989, the reproductive rate was low, but in 1990, it was above historical levels. When compared to previous years, no significant differences could be detected in calving rates. Throughout most of their range, humpback whale reproductive rates are characterized by high variability. There were no humpback whale deaths or strandings observed between 1989 and 1990 in Prince William Sound following the Exxon Valdez Oil Spill.

North Pacific Right Whale

The estimated percentage of VLOS trajectories contacting (within 110 days in summer) North Pacific right whale ERAs in the proposed Lease Sale Area (ERAs 73 and74; Appendix A, Table A.1-8) is as follows (with references to relevant maps and tables in Appendix A):

- ≥0.5% to <6% – ERA 73, NPRW Feeding Area (Map A-2f).

The OSRA model estimates ERA 74 (NPRW Critical Habitat; Appendix A, Map A-2d) has <0.5% of trajectories contacting from a VLOS and is unlikely to be impacted. North Pacific right whales are considered vulnerable in these areas from June to September (Appendix A, Table A.1-8). ERA 73 occurs along the eastern extent of Kodiak Island, an area deemed a feeding BIA for North Pacific right whales (Ferguson, Curtis, and Harrison, 2015). The highest densities of these whales in this area occur from June through September (Ivashchenko and Clapham, 2012; Mellinger et al., 2004; Wade et al., 2011a,b; Waite, Wynne, and Mellinger, 2003), with few if any data available from other months. ERA 73 also occurs adjacent to designated North Pacific right whale critical habitat. Due to the extremely low population numbers of North Pacific right whales, any direct or indirect effects from a VLOS on this species would be severe and likely have adverse impacts at the population level.

Harbor Porpoise

The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter unless otherwise noted) harbor porpoise ERAs in Cook Inlet and the surrounding region (ERAs 101 to 107; Appendix A, Table A.1-8) is as follows (with references to relevant maps and tables in Appendix A):

- ≥50% – ERA 104, Cook Inlet 4 Harbor Porpoise (in summer only) (Map A-2c);
- ≥25% to <50% – ERA 102, Cook Inlet 2 (Map A-2a); ERA 103, Cook Inlet 3 (Map A-2c); and ERA 105, Cook Inlet 5 (Map A-2b) (all in summer only); and
- ≥6% to <25% – ERA 101, Cook Inlet 1 (in summer only) (Map A-2a).

The OSRA model estimates harbor porpoise ERAs 106 (SE Kodiak) and 107 (S Kodiak) have <0.5%of trajectories contacting from a VLOS and are unlikely to be impacted. There are no harbor porpoise ERAs estimated to be contacted in winter months. Harbor porpoises are listed as vulnerable in these areas from June to December (Appendix A, Table A.1-8) but may be present year-round.

Dall's Porpoise

The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter unless otherwise noted) Dall's porpoise ERAs in Cook Inlet and the surrounding region (ERAs 81 to 88; Appendix A, Table A.1-8) is as follows (with references to relevant maps and tables in Appendix A):

- ≥6% to <25% – ERAs 81 to 83, Cook Inlet MM1a to 3a (in summer only) (Map A-2d); and
- ≥0.5% to <6% – ERAs 84 to 87, Shelikof MM 4a, 5a, 6a, 9 (all in summer only) (all shown on Map A-2d).

No contact during the winter season to any Dall's porpoise ERA is estimated, and ERA 88 (Shelikof MM 10; Appendix A, Map A-2h) is not estimated to be contacted in either season. Dall's porpoise are deemed vulnerable in these areas from June through August (Appendix A, Table A.1-8). The OSRA model estimates <5% chance of contact to ERA 88, and so it will not be discussed further. Concentrations of Dall's porpoise have been reported in Shelikof Strait and around Kodiak and Afognak Islands (USDOI, MMS, 2003).

4.12.6.6.2. Pinnipeds

Harbor Seal

The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter unless otherwise noted) one of the 33 harbor seal ERAs in Cook Inlet and the surrounding region (ERAs 11 to 44) is as follows (with references to relevant maps and tables in Appendix A, including Table A.1-9):

- ≥50% – ERA 11, Augustine; ERAs 12 and13, South Cook HS 1a to c; ERA 17, Clam Gulch HS (in summer only) (all shown on Map A-2a)
- ≥25% to <50% – ERA 15, South Cook HS 1d; ERA 18, Tuxedni HS; ERA 17, Clam Gulch HS (in winter only) (all shown on Map A-2a)
- ≥6% to <25% – ERA 19, Kalgin Island HS (Map A-2a); ERA 23, Barren Islands Pinnipeds (Map A-2b); ERA 16, Inner Kachemak Bay (in summer only) (Map A-2b); ERA 20, Redoubt Bay HS (in summer only) (Map A-2b); ERA 26, Shelikof MM4 (in summer only) (Map A-2d); and
- ≥0.5% to ≤5% – All other harbor seal ERAs (see Table 4.12.6-1)

Harbor seals are listed as vulnerable in ERAs 11 to 17 and 23 to 44 year-round, and in ERAs 18 to 22 from March to December (Appendix A, Table A.1-9). Harbor seals are regularly seen throughout Cook Inlet, especially during spring eulachon and summer salmon runs (Nemeth et al., 2007); potentially affected stocks in Cook Inlet (Cook Inlet/Shelikof and North and South Kodiak stocks) are generally considered non-migratory and show strong site fidelity for haul-outs during the breeding season (Pitcher and McAllister, 1981; Small et al., 2005). Important harbor seal haul-out areas occur within Kamishak and Kachemak Bays and along the coast of the Kodiak Archipelago and the Alaska Peninsula. Chinitna Bay, Clearwater and Chinitna Creeks, Tuxedni Bay, Kamishak Bay, Oil Bay, Pomeroy and Iniskin Islands, and Augustine Island are also important spring-summer breeding and molting areas and known haul-out sites (Boveng, London, Ver Hoef, 2012). The ERAs discussed earlier occur in the southern extent of Cook Inlet, throughout these important harbor seal haul-out areas; the highest percent chance ERAs occur on the southwestern side (in and near Kamishak Bay), and with relatively lower percent chance of contact to ERAs on the southeastern side (near the southern extent of the Kenai Peninsula).

Steller Sea Lion

The OSRA model estimates the percent of trajectories contacting from a VLOS within 110 days in summer and winter (unless otherwise noted) to one of the 21 Steller sea lion ERAs in Cook Inlet and the surrounding region (ERAs 23 to 44) is as follows (with references to relevant maps and tables in Appendix A, including Table A.1-9):

- ≥6% to <25% – ERA 23, Barren Islands Pinnipeds (Map A-2b); ERA 26, Shelikof MM4 (in summer only) (Map A-2d); and
- ≥0.5% to <6% – All other harbor seal ERAs (see Table 4.12.6-2).

Steller sea lions are listed as vulnerable in these ERAs year-round (Appendix A, Table A.1-9). All of the ERAs occur within the WDPS Steller sea lion critical habitat (58 *FR* 45269, August 27, 1993), so designated because this area contains important habitat features such as rookeries (e.g., ERAs 31 and 23), major haul-outs (and their surrounding aquatic zones), and aquatic foraging areas (e.g., ERAs 24 to 26).

Fur Seal

Because the main habitat range of fur seals occurs outside of the proposed Lease Sale Area in the Gulf of Alaska (Consiglieri et al., 1982; Loughlin et al., 1999; Merrick, Loughlin, and Calkins, 1987), their exposure to oil would likely be limited to the oil that reaches the Gulf of Alaska from the origin point in Cook Inlet. Although ERAs are not identified specifically for fur seals, they are known to use some of the same areas as the WDPS of Steller sea lions (see previous discussion). Most of the ERAs occur near Kodiak Island and Shelikof Strait. Fur seals may be particularly prone to oil exposure in these areas during their seasonal migration through the Gulf of Alaska in April through June and October, although they may be found throughout their range at any time of the year. The northward migration of individuals wintering in southern parts of the range begins in March, and from April to mid-June, large numbers are found in Gulf of Alaska coastal waters (Consiglieri et al., 1982). By April, the seal migration reaches the vicinity of Kodiak Island, and during the summer, after adult females and males have migrated through the Aleutian Islands and into the Bering Sea, the majority of fur seals remaining around Kodiak Island are non-breeding individuals. Southward migration from the Pribilof Islands begins in October; by December, seals appear off southeast Alaska (USDOI, MMS, 2003).

4.12.6.6.3. Fissipeds

Because sea otters use both land and water features, ERAs, LSs, and GLSs were used in the OSRA model to estimate the highest percentage of VLOS trajectories contacting their habitat range (see Table 4.12.6-3). The estimated percentage of trajectories VLOS contacting (within 110 days in summer and winter unless otherwise noted) one of the 26 sea otter ERAs in Cook Inlet and the surrounding region (ERAs 16, 45 to 68, and 145) is as follows (with references to relevant maps and tables in Appendix A, including Table A.1-10):

- ≥50% – ERA 46, Outer Kachemak Bay (summer only); ERA 47, SW Cook Inlet; ERA 48, Kamishak Bay (all shown in Map A-2b);
- ≥25% to <50% – ERA 45, Clam Gulch (winter only) (Map A-2a); ERA 46, Outer Kachemak Bay (winter only) (Map A-2b);
- ≥6% to <25% – ERA 16, Inner Kachemak Bay (in summer only) (Map A-2b); ERA 45, Clam Gulch (in summer only) (Map A-2a); ERA 49, Katmai National Park (Map A-2e); ERA 64, Afognak West (Map A-2e); ERA 67, Shuyak (Map A-2e); ERA 68, Kenai Fjords West (Map A-2b); and
- ≥0.5% to ≤5% – All other sea otter ERAs (see Table 4.12.6-3).

Sea otters are vulnerable in these ERAs year-round (Appendix A, Table A.1-10). Eleven of the ERAs (ERAs 47 to 51, 57, 59, 60, 64, 66, and 67) occur within northern sea otter Southwest Alaska DPS critical habitat. The three ERAs with the highest percent (≥50%) of VLOS trajectories contacting them are areas with abundant numbers of sea otters: Kachemak Bay (ERA 46), Kamishak Bay (ERA 48), and along the southwestern coast of Cook Inlet (ERA 47) (Bodkin et al., 2003; Gill et al., 2009).

The estimated percentage of VLOS trajectories contacting (within 110 days in summer and winter unless otherwise noted) one of the seven sea otter LSs in Cook Inlet and the surrounding region (LSs 7, 15, 35, 65, 84, 86, 87, and 92) is as follows (with references to relevant maps and tables in Appendix A, including Table A.1-10):

- ≥6% to <25% – LS 35, Tuxedni Bay (Map A-3c); and
- ≥0.5% to ≤5% – LS 84, Raspberry Strait (Map A-3b); LS 86, Uginak Bay/Passage (Map A-3b); LS 87, Uyak Bay (Map A-3b).

All other sea otter LSs in Appendix A, Table A.1-10, have <0.5% of VLOS trajectories contacting them and are unlikely to be impacted. Sea otters are vulnerable in these LSs year-round. LS 35 is adjacent to

Tuxedni Bay, designated sea otter critical habitat. LSs 84, 86, and 87 are on the eastern side of Kodiak Island, also adjacent to the SWDP sea otter critical habitat.

The estimated percentage of VLOS trajectories (within 110 days in summer and winter unless otherwise noted) one of the nine sea otter GLSs in Cook Inlet and the surrounding region (GLSs 119, 124, 141, 144, 146, 149, 150, 152, and 159) is as follows (with references to relevant maps and tables in Appendix A, including Table A.1-10):

- ≥6% to <25% – GLS 141, Seldovia side Kachemak Bay (Map A-4b); and
- ≥0.5% to ≤5% – GLS 124, Kukak Bay (Map A-4b); GLS 152, Barren Islands (Map A-4a); GLS 159, Kupreanof Strait (Map A-4a).

All other sea otter GLSs in Appendix A, Table A.1-10, have <0.5% trajectories contacting from a VLOS and are unlikely to be impacted. GLS 124 is along Kukak Bay on the eastern side of the Alaska Peninsula, and GLS 152 is in the Barren Islands; both are adjacent to SWDP sea otter critical habitat.

4.12.6.7. Conclusion

In summary, available evidence does not suggest significant population-level impacts would occur to fin whales, humpback whales, sei whales, sperm whales, Pacific white-sided dolphins, Cuvier’s beaked whales, Baird’s beaked whales, Stejneger’s beaked whales, harbor porpoises, Dall’s porpoises, or blue whales as a result of a VLOS in Cook Inlet. However, for reasons discussed in Section 4.12.6, if individual small or large groups of whales concentrated in high-value feeding and migratory corridors were exposed to large amounts of fresh oil, especially through inhalation of highly toxic aromatic fractions, they could be seriously injured or die.

There is compelling evidence linking cetacean death or serious injury to oil exposure (Martineau et al., 1994, 2002; Matkin et al., 2008; Peterson et al., 2003; Venn-Watson et al., 2015). Severe effects at the individual and population levels may occur from a VLOS to those species known to suffer severe effects from previous VLOS events (i.e., killer whales and gray whales) and species with small population numbers (i.e., Cook Inlet beluga whales and North Pacific right whales) more susceptible to adverse effects resulting from catastrophic events.

The disappearances (and probable deaths) of killer whales and the deaths of large numbers of gray whales coincided with the Exxon Valdez Oil Spill and with observations of members of both species in oil (Matkin et al., 2008). Depending on the time of year and extent of the VLOS, killer whales and gray whales exposed to oil may suffer severe impacts.

Cook Inlet beluga whales may be severely impacted at the individual and population levels by a VLOS event. A strong correlation was found between high levels of PAHs and illness and mortality of beluga whales in the Saint Lawrence Estuary (Martineau et al., 1994, 2002), underscoring the susceptibility of beluga whales to this class of contaminants. The chronic PAH contamination in the Saint Lawrence Estuary represents a clear threat to the health status of resident species; beluga whales in this area have shown a greater prevalence of cancer than any other group of cetaceans in the world (Martineau et al., 2002). Being of the same species, and also a residential population, Cook Inlet beluga whales may be similarly affected if chronic PAH contamination results from a VLOS. The NMFS Draft Cook Inlet Beluga Recovery Plan indicated that a spill in a more centrally located area of Cook Inlet beluga habitat will increase the exposure of the animals and increase the severity of the impact, to the point recovery of the population could be delayed (NMFS, 2015a).

Small populations such as Cook Inlet beluga whales and North Pacific right whales may be more susceptible than large populations to adverse effects resulting from catastrophic events. The reduced summer range of Cook Inlet beluga whales into upper Cook Inlet makes them vulnerable to catastrophic events that could kill or injure a significant portion of the population. As the OSRA trajectory results estimate the percent chance of contact between 25% and 50% in both summer and winter to beluga whale critical habitats, they may be exposed to oil in these and other areas and suffer direct and indirect impacts.

Research on the North Pacific right whale suggests there are approximately 30 whales remaining in the eastern population (Wade et al., 2011b). Detections of right whales have become very rare in the Gulf of Alaska (Allen and Angliss, 2015). However, from 2004 to 2006, four sightings of right whales occurred in the Barnabus Trough region on Albatross Bank, south of Kodiak Island (Wade et al., 2011b). OSRA results indicate a ≥0.5% to ≤5% chance of contact in summer in the North Pacific right whale ERA 73, which occurs in a feeding BIA adjacent to their critical habitat. Whales in these areas may be exposed to oil from a VLOS and suffer direct and indirect impacts. As stated earlier, small populations such as the North Pacific right whale are more susceptible to adverse population-level effects from catastrophic events such as a VLOS. The injury, mortality, or reduced fitness of one whale from direct and indirect VLOS effects is considered a severe population-level impact.

In the event of a VLOS, harbor seals, fur seals, and Steller sea lions could be adversely affected to varying degrees depending on habitat use, densities, season, and oil spill characteristics. For harbor seals, residual effects of the original spill are unlikely. During the initial Exxon Valdez Oil Spill, harbor seals were exposed via direct contact with the oil and possibly indirectly through consumption of contaminated food. These exposures were short-lived and probably unimportant in the years subsequent to the oil spill (Hartung, 1995). Although harbor seal populations declined at a greater rate at oiled sites compared to unoiled sites in 1989, these differences were transient and no longer discernible by 1990. The effects on harbor seals are anticipated to be minor.

For Steller sea lions, based on research conducted during and after the Exxon Valdez Oil Spill, none of the data presented and analyzed provided conclusive evidence of an effect (Calkins et al., 1994). On this basis, potential impacts to Steller sea lions are anticipated to be minor.

In addition to the discussed effects to pinnipeds from inhaling and ingesting oil, fur seals are at an increased risk of severe effects (including large mortality events) from hypothermia related to oil exposure. Depending on the volume, a VLOS that contacted the Kodiak/Shelikof Strait area in fall or spring may cause mortality to a large number fur seals migrating through the area. Population-level effects from large numbers of mortalities have not been determined from previous VLOS events on this species. The effects may be minor to severe.

A VLOS could cause major immediate and long-term impacts to sea otters. As described previously, large mortality events were associated with the Exxon Valdez Oil Spill, during which mortality of sea otters numbered in the thousands the first year, and spill-related mortalities continued for several years. The Prince William Sound population of sea otters was not considered fully recovered from the oil spill until 2014, 25 years after the spill occurred. Chronic effects to sea otters from exposure to oil have been shown to affect mortality patterns, abundance, and survival rates in the years following the Exxon Valdez Oil Spill. Sea otters may also suffer long-term impacts if their prey species are substantially reduced in quantity or quality and do not recover to sufficient levels to maintain the fitness of these populations.

The magnitude and duration of potential impacts of a VLOS on marine mammals depends on the timing of the spill and the distribution of animals in the affected area. For some populations, the direct impact to the animals and the indirect impact to their habitats and feeding areas could be **major**.

4.12.7. Terrestrial Mammals

The coasts of Cook Inlet provide habitat critical in the life cycle of several terrestrial mammal species. Degradation of this habitat could have long-lasting impacts on some species, particularly on isolated populations, some of which are already in decline, such as the Kenai Peninsula population of brown bears (ADFG, 2000; USFWS, 2014c) and the Kenai Lowland Caribou Herd (ADFG, 2003). The potential impacts of a large oil spill on terrestrial mammals are described in Section 4.3.7. The potential impacts of a VLOS would be similar in nature but greater in magnitude and duration owing to the volume and duration of the release. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on terrestrial mammals are described in the following sections.

4.12.7.1. Phase 1 (Initial Event)

The potential impacts of the initial event on terrestrial mammals would likely be limited to the effects of smoke produced from a fire such as that from a burning platform. Any terrestrial mammal within the plume of smoke could be affected, with the level of impact related to the volume of smoke produced and environmental conditions during the fire. Wind strength and direction would be key elements determining the direction of the smoke plume, the amount of smoke reaching the shoreline, and the degree to which the plume is dispersed before reaching the shoreline. Larger mammals may be affected to a greater extent than smaller mammals as smaller species of terrestrial mammal typically occupy ground-level habitats, which would likely be clear of smoke. Larger mammals, while potentially more exposed to the smoke plume, would also be more capable of avoiding the plume by moving out of its path. It is very unlikely that a fire from a burning platform would reach the shore. Given the distance between offshore platforms and shore, smoke would likely disperse by the time it reached land.

4.12.7.2. Phase 2 (Offshore Spill)

Terrestrial mammals by definition will primarily be found in onshore areas. Some terrestrial mammals may be affected by killing or scavenging prey contaminated by oil. Contamination may then be passed on through the food web potentially resulting in short- and/or long-term health impacts. These impacts were described in more detail in Section 4.3.7.

4.12.7.3. Phase 3 (Onshore Contact)

In the event that oil from a VLOS reaches shore, populations of terrestrial mammals could be impacted depending on the size of the oiled area and the time of the year. Direct contact with oil and contamination of food items could have short- and/or long-term impacts to animal health. A loss of foraging areas or food resources could result in animals shifting to alternate diet resources, or malnutrition if there are not enough edible resources remaining to maintain adequate health. Loss of other important habitat (e.g., rutting, wintering, and calving areas) could cause behavioral changes that might disrupt local populations.

As described in Section 4.3.7, tissue irritation and hypothermia are possible effects of heavily oiling on animals. The greatest direct contamination risk would arise from ingestion of oil through food and grooming of oiled fur, and inhalation of oil constituents in the air. Ingested oil can result in numerous health effects, depending on the quantity of oil consumed and the physical and chemical state of the oil at the time of ingestion.

Contamination of coastal areas by spilled oil could result in loss of seasonally critical food items for several terrestrial mammal species. As described in Sections 4.3.7, 3.2.4.1, and 3.2.4.2, tidal flats and coastal marshes provide important forage (intertidal molluscs and marine worms, and sedges, grasses and forbs, respectively) for brown and black bears emerging from hibernation in the early spring (Smith and Partridge, 2009). Salmon in coastal rivers are important prey items during the summer and fall (ADFG, 2015a; Glenn, 1980) as bears prepare for hibernation. Beaches in the Kodiak Archipelago and Prince William Sound provide important winter habitat and foraging areas for black-tailed deer (Van Daele, Svoboda, and Crye, 2013; Veeramachaneni, Amann, and Jacobson, 2006) and elk (ADFG, 2015a; AKNHP, 2011). Loss of these food resources by the animal populations that depend on them could result in the animals seeking alternate sources of nutrition that may be less nutritious or less available than those they typically use. The search for replacement food items may lead affected animals into unfamiliar or less frequently used areas where they may come into conflict with other animal populations over available resources or be subject to increased predation. Loss of food resources could result in a decrease in nutritional status for affected animals, impacting overall fitness and survival.

Important wintering areas used by black-tailed deer, elk, and moose as well as rutting, wintering, and calving areas used by moose are included in the GLSs most likely to be contacted by oil from a VLOS. Wintering areas used by black-tailed deer and elk in the Kodiak Archipelago are also important feeding areas for these species. Loss of areas used for rutting, wintering, and calving could force animals to relocate to less suitable habitats, where they may face reduced shelter and increased predation. An oil spill affecting salmon populations and reducing the size of spawning runs, while directly impacting species such as brown bears through the reduction or elimination of a critical food source, could have an indirect impact on deer, caribou, elk, and moose. Salmon runs provide an annual nutrient surge linking marine and terrestrial ecosystems (Reimchen et al., 2003), and the loss of this seasonal nutrient input could reduce the quality and quantity of streamside vegetation, reducing the forage base for ungulates. In addition to being a source of food, streamside vegetation also provides habitat for many species. Loss or reduction of salmon as a food source by brown bears may also result in increased predation by bears on young ungulates (ADFG, 2015a).

4.12.7.4. Phase 4 (Spill Response and Cleanup)

Spill response activities could increase disturbance in the affected area, potentially driving some animals into alternate and less suitable habitat, which in turn may result in reduced nutrition, increased energy expended in foraging, increased predation, and increased competition over habitat and food resources. Spill response activities would involve the use of vessels and aircraft, resulting in increased activity at shore bases and airports. Spill response activities may increase the possibility of encounters between cleanup crews and animals into whose habitat the cleanup crews intrude. Many of the areas likely to be contacted by oil are tidal flats and coastal marshes heavily used by brown bears during spring (Smith and Partridge, 2009). The presence of cleanup crews in these areas may deny access to bears that depend on the food resources they contain. Owing to the high nutritive value of these resources, bears may be unwilling to evacuate the area and may perceive cleanup crews as intruders or prey. Actions would be taken to protect the safety of cleanup crews, which may result in reduced access to bears, possible tranquilization, relocation, or killing of “problem bears.” Impacts of oil spill response activities affecting salmon streams may be reduced to some extent if bears are able to relocate to stretches of river not impacted by cleanup activities.

4.12.7.5. Phase 5 (Post-Spill, Long-Term Recovery)

Coastal marshes degraded by oil exposure may take decades to recover (Hoff, 1995; Mendelssohn et al., 2012) or may be permanently lost. Animals depending on marsh vegetation to meet nutritional needs would be forced to seek alternative food sources that may be less plentiful and less nutritious. Soil contamination may persist for years with toxins transferred to growing plants and on to animals feeding on these plants. Kelp beds destroyed by an oil spill may take many years to recover to a mature, mixed-age community. The interim result would be periodic, synchronous die-offs as stands of kelp of a single age class mature and die (EVOSTC, 2010). The black-tailed deer of Kodiak and Afognak Islands that depend on kelp to supplement their winter diet may be deprived of regular access to this resource for years, potentially compromising their ability to survive the winter. While crude oil coating a beach may be removed within a few months by cleanup efforts or via natural processes, contamination of the soil may continue for years. Toxins sequestered in the sediments would likely be ingested by infauna and then passed on to animals taking advantage of this food source. Salmon eggs in natal streams could absorb toxins deposited within the sediments, causing mortality or mutation of fish larvae (Peterson et al., 2003). Adult salmon may be directly impacted by an oil spill reducing their numbers or they may absorb contaminants without suffering any immediate effect. Loss or reduction of salmon as a food resource, or contamination of this resource, would have long-term impacts for many species of terrestrial mammals inhabiting the Cook Inlet area, as salmon are an integral component of the food web in this area (ADFG, 2015a; Glenn, 1980). Indirect long-term effects of a substantial decrease in salmon populations could result in a loss of important nutrients in area rivers, causing a decrease in streamside vegetation, which serves as a food source and as habitat for many species (Reimchen et al., 2003). No species would likely be as affected by a decrease in the salmon population more than the brown bear, and black bears to a lesser extent. Brown bears often attack and kill black bears, and exclude them from the more productive habitats when possible. Impacts to brown bear populations would likely cascade through the ecosystem as brown bears seek out alternate food sources. Contamination of salmon could have severe long-term impacts to brown bear health and populations if contaminated salmon are consumed. Contamination of nearshore fish or invertebrates could have similar long-term health impacts for species that rely heavily on this food source, such as otters (Larsen, 1984) and mink (Allen, 1986). Cleanup activities may further impact contaminated habitats, for example killing marsh vegetation or forcing oil deeper into sediments (Mendelssohn et al., 2012) by using inappropriate methods in an attempt to remove contamination. Poaching of some species may increase as a VLOS could affect certain sectors of the economy. Isolated populations of terrestrial mammals could suffer population losses from which recovery may be impossible.

4.12.7.6. Oil-spill Risk Analysis

Terrestrial mammals in Cook Inlet and the surrounding region are represented in the OSRA model by GLSs listed in Table A.1-14 of Appendix A. A summary of the highest percentage of VLOS trajectories contacting (within 110 days during summer and winter) terrestrial mammal resources is provided in Table 4.12.7-1.

Table 4.12.7-1. Highest Percentage of VLOS Trajectories Contacting Terrestrial Mammal Resources[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer	Winter
		110 days[2]	110 days
Grouped Land Segment (GLS)	≥0.5–<6	125 (Spring Bear Concentration-1), 137 (West Kenai Moose)	125 (Spring Bear Concentration-1), 129 (Redoubt Bay Brown Bears), 131 (Trading Bay Moose), 136 (West Kenai Brown Bears), 137 (West Kenai Moose), 140 (West Kenai Black Bears), 160 (Kodiak Black-Tail Deer)
	≥6–<25	129 (Redoubt Bay Brown Bears), 136 (West Kenai Brown Bears), 140 (West Kenai Black Bears)	155 (Afognak, Raspberry Winter Elk), 157 (Afognak Black-Tail Deer)

Notes: [1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) is the same as 110 days in both seasons, but the individual results from each LA may not be identical.
Source: Appendix A (Tables A.1-14, A.2-30, A.2-35, A.2-50, and A.2-55). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

Potential impacts of a VLOS on terrestrial mammals would be similar to the impacts discussed in Section 4.3.7, but greater in the magnitude, extent, and duration. Estimated impacts are based on the percent of trajectories from a VLOS will contact GLSs important to terrestrial mammals within 110 days of the initial event as estimated by the OSRA model (Table 4.12.7-1). The western shore of Redoubt Bay, including coastal areas of the Redoubt Bay Critical Habitat Area, and the tidal flats, coastal marshes, and salmon streams in GLS 129 in particular, provide important foraging areas for brown bears from March through October. GLS 136 on the western coast of the Kenai Peninsula provides similar foraging habitat for brown bears from June through October, and GLS 140 in the southwest corner of the Kenai Peninsula provides foraging habitat for black bears during this time period. GLS 137 contains rutting, wintering, and calving areas used by moose. GLS 131 is an important wintering ground for moose on the west side of Cook Inlet. GLS 125, on the northeast shore of the Alaska Peninsula, directly west of Afognak Island, consists of a high percentage of tidal flats supporting springtime concentrations of brown bear. Coastal areas of Afognak Island (GLSs 155 and 157) provide wintering habitat for black-tailed deer and elk. GLS

160 consists of most of the eastern and southwestern coast of Kodiak Island and is an important wintering area for black-tailed deer. Potential species-specific impacts are summarized in the following sections.

Brown Bear

The area surrounding Cook Inlet supports some of the highest densities of brown bears found in the world (Glenn, 1980). Abundant food resources also allow the exceptional fecundity of brown bear populations in the Kodiak Archipelago and the Katmai region of the Alaska Peninsula. Female brown bears in these areas produce higher numbers of offspring than elsewhere (Modafferi, 1984). These populations depend on food sources in tidal flats and coastal marshes during the spring when brown bears most quickly regain body mass lost during hibernation (Smith and Partridge, 2009).

Direct impacts such as the loss of early spring forage would make it difficult for bears to quickly regain the body mass lost during hibernation. Similarly, any substantial decrease in the numbers of salmon returning to area rivers would further stress the health of these animals due to the importance of this food item in increasing body mass prior to hibernation. The importance of coastal resources in maintaining the health of bear populations surrounding Cook Inlet, and the relative scarcity of alternate food resources capable of supporting this dense population, may make it more likely that bears will consume contaminated food items. Ingestion of toxins contained in crude oil could result in illness or death for affected bears, further impacting the population.

An indirect impact of the loss of food resources typically exploited by brown bears is the attempt to access alternate food sources in different habitats, which would likely result in increased expenditure of energy in return for a less-nutritious diet. Already stressed by malnutrition, brown bears, particularly females and cubs, would be less able to compete for limited resources against adult male brown bears or other species. Female brown bears with cubs frequently utilize substandard habitat in order to reduce interactions with male bears (Stayaert et al., 2013). With male bears potentially shifting foraging to alternate habitat due to contamination of, or loss of access to, preferred habitat, greater pressure would be experienced by females with cubs as they attempt to secure adequate food sources while avoiding male bears. A side effect of the potential malnutrition experienced by female bears could be decreased production of juveniles during hibernation, and a reduced ability of females to provide adequate nutrition for newborn cubs. Combined with increased juvenile mortality due to loss of food resources, and potentially increased predation by male brown bears (Sellers and Miller, 1999), lowered production of cubs could result in a substantial decrease in recruitment to area populations.

Short-term impacts, such as those described previously, could be further compounded by long-term effects of a severe and extensive oil spill. Marshes destroyed by contact with oil may take decades to recover (Hoff, 1995; Mendelssohn et al., 2012), and if oiling is severe enough, they may not recover at all. Coastal populations of brown bears may be forced to forage in less-productive habitats farther inland. Sequestering of toxins in the sediments of riverbeds or tidal flats may last for years, contaminating infauna and increasing mortality and mutations among newly hatched salmon larvae (Peterson et al., 2003). Contaminated food supplies combined with loss of productive foraging habitat could impact area bear populations for years. The bears of the Kenai Peninsula, a stressed and genetically isolated population (ADFG, 2000; USFWS, 2014c), could suffer population-level effects from which recovery could be difficult.

Black Bear

Black bears face the same threats posed by a VLOS as those faced by brown bears, but to a lesser extent due to the fact that black bears are less reliant on coastal resources than brown bears in the Cook Inlet area. Direct impacts include the loss, reduction, or contamination of coastal resources, particularly salmon. Indirectly, the loss of these resources by brown bears may force them into habitat typically used by black bears, potentially displacing black bears into more marginal habitat and increasing conflict between the species. Short-term effects such as increased mortality in the months directly following an oil spill, combined with decreases in health due to malnutrition and ingestion of contaminated food items, impact black bear populations for years. While black bears consume many of the same food items as brown bears, the diet of black bears is less dependent on coastal resources (Mattson et al., 2005), and brown bears often exclude black bears from the more productive habitats in Alaska.

Wolf

While wolves are known to use coastal resources such as fish and marine mammal carcasses (Watts et al., 2010) as well as salmon (Crowley, 2012; Riley, 2012a), moose and caribou constitute their primary prey in Alaska (ADFG, 2016). The primary risk of oil from a VLOS reaching shore would be ingestion of oil due to grooming or consumption of contaminated food items. However, coastal food resources are less important to the diet of wolves than are typical terrestrial food sources.

Coyote

Like wolves, coyotes are known to use coastal food resources to supplement their varied diet (ADFG, 2016), and they face similar risks involving ingestion of spilled oil. However, coastal food resources play a marginal role in the diet of coyotes.

Red Fox

The omnivorous red fox (ADFG, 2016) takes advantage of the seasonal abundance of food provided by annual salmon runs by catching live fish and scavenging carcasses (Cederholm et al., 1999). Oil reaching the shoreline from a VLOS presents a risk of ingestion of spilled oil by coastal foraging red foxes through grooming and consumption of contaminated food items. These impacts are expected to affect individuals without causing population-level impacts as many, more typical food items would remain unaffected by an oil spill.

American Mink

Potential impacts of a VLOS on mink include direct contact with oil, ingestion of oil during grooming, consumption of contaminated prey, reduced food supplies, and increased competition with river otters. If the amount of oil reaching the beach is extensive and severe enough, contamination of nearshore fish and invertebrates could have long-term impacts on health, mortality, and population dynamics of this species. Mink and river otter typically display pronounced resource partitioning, even in areas where food is abundant (Ben-David, Bowyer, and Faro, 1996), with otters generally foraging farther offshore and mink spending more time foraging terrestrially. Impacts to mink would be expected to be **minor** due to the more varied diet (Allen, 1986) of mink, allowing them to use a wider range of alternate foraging habitat.

River Otter

Direct contact with oil, ingestion of oil during grooming, consumption of contaminated prey, forced relocation due to habitat degradation (Bowyer et al., 1995), reduced food supplies, and increased competition with mink are potential impacts of a VLOS on river otters. Contamination and loss of nearshore resources could force otters to spend more time foraging onshore, potentially increasing competition and conflict with mink as river otters are generally intolerant of the presence of mink (ADFG, 2015a).

Black-Tailed Deer

A VLOS impacting the shorelines of Kodiak and Afognak Islands as well as adjacent islands during the winter could displace black-tailed deer from the beaches they use as winter habitat, and alternate wintering areas farther inland may not provide adequate food supplies. Reductions in kelp beds or contamination of kelp washed ashore as a result of a VLOS could affect deer populations in the long term. Increased predation by brown bears could also occur if VLOS impacts are locally significant.

Caribou

Of the five caribou herds in the immediate vicinity of Cook Inlet, only the Kenai Lowlands caribou herd, which uses wintering and calving areas near the coast north of Kenai (in GLS 136), are likely to suffer direct impacts from a VLOS in Cook Inlet. Direct impacts would likely involve the loss of a small portion of this herd's wintering and calving area due to contamination, and potentially consumption of oil due to contaminated food items or grooming. Indirect impacts related to lost or reduced coastal food supplies could affect caribou nutrition and result in increased predation by brown bears, which could further destabilize the population. However, the coastal environment constitutes a small portion of winter and spring habitat for the Kenai Lowlands caribou herd.

Elk

If oil contamination is severe in the Kodiak Archipelago, elk on Afognak and Raspberry Islands could be forced from coastal winter habitat into less suitable areas with less plentiful food supplies and higher risk of predation.

Moose

Moose wintering areas near Trading Bay (GLS 131) on the west side of Cook Inlet and on the west coast of the Kenai Peninsula (GLS 137) could be impacted by a winter oil spill. Moose could avoid direct impacts from oiled shorelines and cleanup activities; therefore, potential impacts would be indirect and primarily related to increased predation by brown bears and collisions with vehicles.

Dall Sheep

Potential direct impacts resulting from a VLOS would be consumption of oil through contaminated food items or grooming. Indirect impacts could include an increase in vehicle accidents, resulting from increased traffic related to spill response and cleanup activities and possibly increased predation on young. However, in the vicinity of Cook Inlet, Dall sheep have limited interaction with the coastal environment, primarily along the north shore of Turnagain Arm (ADFG, 1985) where they visit mineral licks near the coast.

Mountain Goat

Coastal areas of Prince William Sound, the Kodiak Archipelago, and Kenai Fjords provide foraging opportunities for mountain goats, particularly in the winter and spring (ADFG, 2016). Potential direct impacts resulting from a VLOS include consumption of oil via contaminated food items or grooming. Potential indirect impacts could include increased risk of vehicular accidents due to spill response and cleanup activities and possibly increased predation on young by bears. Côté et al. (2013) found no evidence mountain goats habituate to disturbance from helicopters; therefore increased air traffic associated with spill response and cleanup activities could increase stress among affected populations of goats if the air traffic occurred near mountain goat habitat. However, mountain goat populations in the Cook Inlet area are not found near the airports nearest the Lease Area.

Hoary Marmot

Potential impacts to hoary marmots from a VLOS in Cook Inlet could include those resulting from the direct ingestion of oil through prey as well as indirect impacts due to an increase in the number of humans and vehicles near marmot habitats.

4.12.7.7. Conclusion

Potential impacts resulting from accidental large oil spills on individual species of terrestrial mammals are detailed in Section 4.3.7. Overall impacts to terrestrial mammals from a VLOS in Cook Inlet would be expected to be **major**, with severity depending on the location and timing of the spill and the extent of shoreline oiling in habitats important to terrestrial mammals. Due to their heavy seasonal reliance on coastal resources, brown bear and black-tailed deer face a greater potential risk than many of the other species of terrestrial mammals in the vicinity of Cook Inlet. Direct impacts to brown bear populations may have cascading effects as bears seek alternate foraging areas and food items. This may put brown bears in competition with other carnivores, and increase predation by brown bears on ungulates and rodents. Impacts to sensitive habitat, particularly coastal marshes and mudflats, as well as to isolated mammal populations could require decades to recover.

4.12.8. Birds

A VLOS could result in long-term and population-level impacts to birds, the nature and magnitude of which would depend on the timing and location of the spill, and the species, life stages, and habitats exposed to it. Exposure to oil from a VLOS would have similar types of impacts on bird populations as spills of other magnitudes (detailed in Section 4.3.8); however, the area and the number of species and individuals likely affected would increase, and the degree of impact would be more severe owing to the volume and duration of the oil spill. A much greater number of birds and habitats could be affected and population-level impacts for some species could be incurred as a VLOS can affect extensive areas of shoreline, including IBAs. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on birds are described in the following sections.

4.12.8.1. Phase 1 (Initial Event)

The potential IPFs that could affect marine and coastal birds during this phase include an explosion and fire from a drilling structure or pipeline breach, and minor increases in vessel and helicopter traffic and noise associated with rescue efforts (see Section 4.3). Relatively few birds would be in the immediate vicinity of a drilling structure during an initial event; therefore, few effects on birds are anticipated during the explosion and resulting fire. Only a small number of vessels and helicopters would be involved in rescue efforts, resulting in a negligible increase in traffic and noise impacts to birds.

4.12.8.2. Phase 2 (Offshore Spill)

Direct exposure to oil and gas is the critical IPF that could affect birds during this phase. Oil in offshore waters of Cook Inlet would be a serious threat to seabirds and waterfowl because released oil would form a layer on the sea surface. While shorebirds could be impacted during Phase 2, the risk is considered to be low, except to individual or small flocks of phalaropes that use offshore waters. Passerines and most raptors are not expected to be impacted by a VLOS in offshore waters; however, mortality of bald eagles is expected but not at the population level (Harwell and Gentile, 2006). Seabirds and waterfowl are most vulnerable to offshore oil spills because they spend the majority of their time on the sea surface and often aggregate in dense flocks. The effects likely would be worse during the spring, summer and fall months, owing to the presence of migrating, breeding, juvenile, molting, and staging birds, failed and non-breeders, and the greater number of birds that occur in the area compared to winter; however many species do winter in open water in offshore areas.

Bird deaths due to oil spills are described in Section 4.3.8 and primarily arise from direct contact with oil, resulting in loss of insulation, waterproofing, and buoyancy in the plumage. Such losses may lead to mortality due to hypothermia, exhaustion, starvation, or drowning. Oil ingested during feeding, grooming, and preening can lead to tissue and organ damage as well as interfering with food detection, predator avoidance, homing of migratory species, disease resistance, growth rates, reproduction, and respiration.

Contamination of prey organisms would be expected to occur, resulting in diminished prey abundance and ingestion of contaminated prey (see Section 4.3.4 and 4.3.5 for a discussion of the impacts of oil to lower trophic level organisms and fish). This contamination would be expected to affect a large area of a bird’s foraging range for several months and could reduce growth, survival, or reproductive success for some birds; however, many of the birds that might be affected by this impact would likely die from contact with the oil itself. Birds also could be displaced to potentially less productive secondary foraging locations. Most seabird species that occur in dense flocks offshore in Cook Inlet and the Gulf of Alaska, however, are not believed to be at risk of population-level impacts from one-time stochastic events such as a VLOS. Thus, even though they may potentially incur mortality in the hundreds or thousands, resulting in widespread and therefore moderate levels of impact, at this phase the impact may not be expected to reach the major level of impact for non-listed species.

Threatened and endangered birds impacted by Phase 2 include Steller's eider and, potentially, the short-tailed albatross. Steller's eiders molt and winter in Cook Inlet waters, and are present in the area between late July to mid-March (Rosenberg et.al., 2014; Larned, 2006; Martin et. al., 2015). The level of mortality anticipated during a VLOS likely may not be recovered within several generations, even if the eider populations otherwise remain stable, which could result in population-level impacts to the species. The short-tailed albatross does not breed in or near Cook Inlet and is only an irregular visitor. Within its range, this species should be considered a "continental shelf-edge specialist" (which occurs outside of the Cook Inlet proposed Lease Sale Area) rather than a coastal or nearshore species (Piatt et al., 2006). A VLOS would not be expected to adversely affect foraging habitats for the short-tailed albatross. If an individual short-tailed albatross were directly exposed, it would not result in population-level impacts on the species. However, due to the low numbers of remaining individuals of this species, mortality of a few individuals could have a significant impact on the population. In summary, this phase of a VLOS could be expected to reach moderate levels of impact for non-listed species and major levels of impact for listed species.

4.12.8.3. Phase 3 (Onshore Contact)

Direct exposure to oil and gas is the critical IPF that could affect birds during this phase. Large numbers of waterfowl and shorebirds could come into contact with spilled oil along shoreline areas and in estuaries and bays. These birds could be affected through direct contact with oil, ingestion of contaminated food items, and mortality of prey resources. Although OSRA modeling virtually does not anticipate VLOS reaching the heart of wintering rock sandpiper habitat at Susitna Flats, it could reach other regular rock sandpiper wintering concentration areas (see Table 4.12. 8-1; Ruthrauff, Gill, and Tibbitts, 2013). Such mortality could have population-level effects because large numbers of shorebirds relative to their total population could be affected. Seabirds, raptors, and passerines also could be impacted by oil making onshore contact, although for most species to a lesser extent than waterfowl and shorebirds. For example, raptors might be killed if they were to feed on oiled carcasses. Oiling of coastal or other wetland habitats with concentrations of nesting birds would be expected to cause displacement of nesting birds in the oiled areas and contribute to reduced reproductive success of the birds, and possibly direct mortality of large numbers of eggs and chicks. Reproductive impacts are of particular significance in the short summer period of high northern latitudes, given the high energetic investment in egg laying and nesting. Depending on location, time of year, and species contacted or food-stressed, this phase of a VLOS could cause moderate to major (e.g., direct mortality or impacts to prey of a significant portion of the world's population of the nominate race of rock sandpiper would be considered severe, and therefore major) impacts.

4.12.8.4. Phase 4 (Spill Response and Cleanup)

Disturbance and displacement owing to human, vessel, and aircraft traffic and noise and physical presence, and the use of chemical dispersants are the critical IPFs potentially affecting birds during this phase. Disturbance and displacement could have beneficial effects by moving birds away from oiled areas. Displaced birds may move to unoiled areas with negligible energetic costs if these habitats prove to be of similar quality. Disturbance and displacement could also adversely affect birds if they moved to suboptimal habitats requiring additional energy expenditures (such as increased foraging). Several species have specific requirements for nesting (e.g., islands, cliffs, low-gradient beaches) or foraging (e.g., lagoons, passes between barrier islands), and these habitats could be altered and nests could be destroyed by cleanup efforts. While the birds could relocate to other areas, those areas may be unsuitable and delay avian recovery. Response and clean-up impacts for a large oil spill or discussed further in Ch. 4.3.2.8.6, and response and clean-up impacts from a VLOS would be expected to be similar to these but of somewhat greater intensity and duration. Impacts to non-listed bird species from VLOS response would be expected to be minor for mechanical recovery, other physical presence, and chemical dispersants, because the impacts would be relatively short-term (Andres, 1993). Impacts to listed Steller's eiders from VLOS response may be negligible (if response was completed when and where birds are not present, as in early summer) to moderate, due to the potential long-lasting impacts on their small population via impacts of chemical dispersants on food resources and/or molting birds.

4.12.8.5. Phase 5 (Post-Spill, Long-Term Recovery)

Persistent oil contamination is the critical IPF potentially affecting birds during this phase. Certain oil components introduced to sediment in most offshore and onshore areas, and many of the effects of direct contact with oil, could persist for many years. Certain factors allow components of some spills to persist in the shoreline and adjacent intertidal areas for decades (Li and Boufadel, 2010), including coastlines with armored cobbled shores that can impede oil weathering as well as high ESI shoreline types such as marshes, peat, and fine-grained sediments to which oil clings and persists (Appendix A, Table A.1-2). Oil in subtidal areas could persist for weeks to years based on substrate type. Biodegradation and weathering of oil in cold-water intertidal areas have been shown to be on the order of months to decades (Prince, Owens, and Sergy, 2002). A recent study of biodegradation in the Arctic showed that as temperature increased in the Arctic summer, biodegradation also increased (Chang, Whyte, and Ghoshal, 2011). Therefore, potential effects on large numbers of shorebirds from direct oiling and contaminated prey (as described under Phase 2) could persist for extended periods.

4.12.8.6. Oil-spill Risk Analysis

Birds in Cook Inlet and the surrounding region are represented in the OSRA model by the ERAs and LSs listed in Table A.1-7 of Appendix A. A summary of the highest percentage of VLOS trajectories contacting (within 110 days during summer and winter) bird resources is provided in Table 4.12.8-1. Hundreds of thousands of birds may be present in the proposed Lease Sale Area during the summer months (Section 3.2.5). Table 4.12.8-1 shows that Outer Kachemak Bay IBA (ERA 145) has the highest percentage of trajectories contacting it during the summer, followed by the Kamishak Bay IBA (ERA 136) and the Tuxedni Island Colony IBA (ERA 138). The Outer Kachemak Bay IBA is an important wintering area for seabirds and sea ducks, an important migration stopover for waterfowl and shorebirds, and an important foraging area for seabirds. Birds that use the area include Kittlitz's murrelet, marbled murrelet, white-winged scoter, black scoter, and pelagic cormorant. The Kamishak Bay IBA is an important habitat for non-breeding glaucous-winged gulls as well as other seabirds. The Tuxedni Island Colony IBA contains a seabird nesting colony hosting black-legged kittiwake, common murre, horned puffin, and glaucous-winged gull.

Table 4.12.8-1 shows that the Outer Kachemak Bay IBA (ERA 145, described earlier) and the Lower Cook Inlet IBA (ERA 146) have the highest percentage of VLOS trajectories contacting them during the winter, followed by the Kamishak Bay Steller's Eider Habitat (ERA 137) and the Tuxedni Bay IBA (ERA 139). The Lower Cook Inlet IBA provides foraging habitat for the non-breeding glaucous-winged gull. Kamishak Bay Steller's eider habitat provides wintering habitat for Steller's eider, and the Tuxedni Bay IBA is a fall migration stopover for geese; summer and fall concentration area for scoters; spring migration stopover for long-tailed duck and western sandpiper; black scoter, black oystercatcher, black turnstone, and surf scoter and white-winged scoter utilize the area for molting.

Depending on the source and location of a VLOS, the percentage of trajectories contacting one of these areas within 110 days in summer or winter months ranges from 25% to >50%. Because the percent chance of oil contact to other areas is relatively low (<25%), birds in these areas are considered to be at lower risk, but they could still be contacted by oil. However, the remaining areas listed are IBAs, known bird colonies, or wintering habitat for Steller's eider and they serve important functions for birds in the area.

Based on the large number of birds that occur in the area during the summer months and the likelihood of IBAs being contacted by oil, thousands to hundreds of thousands of birds could be lost as a result of a VLOS that occurred in the summer. The number of birds that could be lost depends on the timing (e.g., early summer versus late summer) and the transport (i.e., if the spill remains offshore, fewer birds might be lost) of the spill. In addition to direct mortality, a VLOS during the breeding season could result in failure to breed, reduced hatching success, higher hatchling mortality, reduced growth rates, reduced fledging success, and higher fledgling mortality rates, all of which would contribute to the overall impact of the spill and the time needed for recovery. Shoreline cleanup efforts could exacerbate the impacts of disturbance on nesting birds and foraging shorebirds.

Although birds are less abundant during the winter, tens to hundreds of thousands of birds winter in the area, especially in the Kodiak-Shelikof Strait region. Based on the more limited distribution of birds during winter compared to summer, the lower number of birds in the area during the winter, the lower percent chance of oil contacting important wintering areas, and the increased oil weathering estimated to occur during winter, thousands to tens of thousands of birds could be lost as a result of a VLOS in winter.

Local reduction or contamination of prey resulting from a VLOS could reduce growth, survival, or reproductive success for some birds; however, many of the birds that likely would be affected by this impact probably would die from contact with the oil itself. If the reduction or contamination of food sources were to persist long after the spill was dispersed or remediated, impacts to local populations of birds also could persist.

Table 4.12-2 Highest Percentage of VLOS Trajectories Contacting Bird Resources[1]

OSRA Feature	OSRA Feature Name	Vulnerable	Specific Resource	Highest Percentage of Trajectories Within 110 days2	
				Summer	Winter
ERA 111	NW Afognak Is IBA	May-August	BLKI (Seabird Colony), BLOY	≥0.5–<6	--
ERA 112	Uganik and Viekoda Bay IBAs	May-August	BLKI (Seabird Colony), BLOY (Criteria B1), KIMU (Criteria A1), MAMU (Criteria A1)	≥0.5–<6	--
ERA 119	Gulf of Alaska Shelf IBA	May-August	CAAU (Foraging)	≥0.5–<6	--
ERA 122	Semidi Islands Marine IBA	May-August	Seabird Foraging: HOPU.	≥0.5–<6	--
ERA 130	South Alinchak Bay Colony	May-August	Seabird Colony: TUPU	≥0.5–<6	--
ERA 132	Amalik Bay Colonies IBA	May-August	Seabird Colonies: RFCO, UNCO	≥0.5–<6	--
ERA 133	Ninagiak Is Colonies	May-August	Seabird Colonies: TUPU, HOPU, GWGU	≥0.5–<6	--
ERA 134	Kiukpalik Is Colony	May-August	Seabird Colony: GWGU	≥0.5–<6	--
ERA 135	Shaw Is Colony	May-August	Seabird Colony: GWGU	≥6–<25	--
ERA 136	Kamishak Bay IBA	May-August	Seabird Colonies: GWGU, Others	≥25–<50	--
ERA 137	Kamishak Bay STEI Habitat	November-April	STEI Wintering Area	≥0.5–<6	≥25–<50
ERA 138	Tuxedni Is Colony IBA	May-August	Seabird Colonies: BLKI, COMU, HOPU, GWGU, Others	≥25–<50	--
ERA 139	Tuxedni Bay IBA	July-April	Shorebird Migration Stopover: WESA. Waterfowl Migration Stopover: CAGO. Waterfowl Molting: SUSC, WWSC.	≥6–<25	≥25–<50
ERA 140	Redoubt Bay IBA	January-December	Shorebird Migration Stopover. Waterfowl Migration Stopover And Breeding Area: Tule WF Geese And Others.	≥6–<25	≥6–<25
ERA 144	Clam Gulch STEI Habitat	November-April	STEI Wintering Area	≥6–<25	≥6–<25

OSRA Feature	OSRA Feature Name	Vulnerable	Specific Resource	Highest Percentage of Trajectories Within 110 days2	
				Summer	Winter
ERA 145	Outer Kachemak Bay/IBA	January-December	Seabird and Sea Duck Wintering; Waterfowl and Shorebird Migration Stopover; Seabird Foraging – MAMU	≥50	≥50
ERA 146	Lower Cook Inlet 153W59N IBA	November-April	Foraging – GWGU	≥6–<25	≥50
ERA 147	Barren Islands Marine IBA	May-August	Foraging-TUPU	≥6–<25	--
ERA 148	Barren Islands Colonies IBA	May-August	Seabird Colonies – TUPU, FTSP, BLKI, COMU, RHAU, GWGU, PECO, HOPU, etc.	≥6–<25	--
ERA 149	SW Kenai Pen Marine IBA	May-August	Seabird Colonies – TUPU, etc.	≥0.5–≤5	--
ERA 151	Gulf of AK Shelf 151W58N IBA	January-December	Foraging – GWGU	≥0.5–≤5	≥0.5–≤5
LS 87	Uyak Bay	May-August	BLKI (Seabird Colony)	≥0.5–≤5	≥0.5–≤5

Notes: -- percent of trajectories are <0.5.
IBA= Important Bird Area; Black-footed Albatross (BFAL), Black-legged Kittiwake (BLKI), Black Oystercatcher (BLOY), Black Scoter (BLSC), Cassin's Auklet (CAAU), Common Murre (COMU), Emperor Goose (EMGO), Fork-tailed Storm-Petrel (FTSP), Glaucous-winged Gull (GWGU), Harlequin Duck (HADU), Horned Puffin (HOPU), Kittlitz's Murrelet (KIMU), Marbled Murrelet (MAMU), Northern Fulmar (NOFU), Pelagic Cormorant (PECO), Red-faced Cormorant (RFCO), Rhinoceros Auklet (RHAU), Rock Sandpiper (ROSA), Sandhill Crane (SACR), Snow Goose (SNGO): Surf Scoter (SUSC), Tufted Puffin (TUPU), STEI (Steller's Eider), Surf Scoter (SUSC), Western Sandpiper (WESA), White-winged Scoter (WWSC).
[1] Highest percentage of trajectories from any LA during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent of trajectories contacting the resource within 30 days (Section 4.3) is the same as 110 days in both seasons, but the individual results from each LA may not be identical.
Source: Appendix A (Tables A.1-7, A.2-25, A.2-30, A.2-35, A.2-45, A.2-50, and A.2-55). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

Therefore, in the unlikely event of a VLOS, the impacts on birds could involve the loss of thousands to possibly hundreds of thousands of birds, depending on the timing (summer versus winter) and movement of the spill in relation to seasonal patterns of bird abundance and distribution. Several IBAs that support thousands of migrating shorebirds and waterfowl, and include numerous seabird colonies occur in Cook Inlet. Spills reaching these areas could directly or indirectly expose adults, eggs, young, and food resources to oil. During migration and in winter, significant portions of some bird species concentrate in Cook Inlet. For example, nearly the entire global population of the nominate race of rock sandpiper overwinters in upper Cook Inlet embayments. These species could be vulnerable to population-level impacts from an accidental oil release. Because of the large number of Steller's eider that overwinter in coastal areas of Cook Inlet (particularly in the vicinity of Kachemak Bay and Kamishak Bay), an accidental spill reaching wintering areas could impact a large number of birds. This species congregates in shallow vegetated nearshore habitats, and spills contacting such areas could reduce local foraging habitat and food resources, and contaminate potential prey. Virtually any impact to the short-tailed albatross could have significant repercussions to the species.

4.12.8.7. Conclusion

A VLOS could affect large numbers of birds and avian habitats owing to the toxicity of oil to individuals and to prey, particularly in light of the time these birds spend on the surface of marine and coastal waters. Under a hypothetical VLOS scenario, birds in key areas or at key times of the year could experience a variety of negative effects from exposure to oil and oiling of avian habitats. Key areas evaluated include the following:

- Kamishak Bay IBA

- Tuxedni Colony IBA
- Kamishak Bay Steller's Eider Habitat
- Tuxedni IBA
- Outer Kachemak Bay IBA; and
- Lower Cook Inlet IBA

All of these areas provide important nesting, molting, wintering, or migration habitat to a variety of seabirds, waterfowl, and shorebirds. The Kamishak Bay Steller's Eider Habitat is especially important to Steller's eiders that molt there. A VLOS during periods of peak use could affect large numbers of birds. The magnitude of potential mortality could result in significant impacts to ESA-listed species and seabird colonies. Large-scale mortality could occur to migrating or molting concentrations of birds. Mortality from a hypothetical VLOS could result in population-level effects for most seabird, waterfowl, and shorebird species utilizing the area.

A review of bird mortality from accidental large spills (Section 4.3.8) revealed that mortality from a VLOS could result in the loss of thousands to hundreds of thousands of birds. The timing (i.e., if peak periods in bird density overlap temporally with the spill) (Fraser et al., 2006), location (high versus low bird density area), and environmental conditions (e.g., wind conditions, wave action, distance to the shore) may have a greater overall effect on bird mortality than the spill size and fluid type (Byrd, Reynolds, and Flint, 2009; Castège et al., 2007; Wilhelm et al., 2007).

Because of the number of IBAs in Cook Inlet that support thousands of shorebirds, waterfowl, and seabirds, oil contamination in these areas could directly or indirectly expose adults, eggs, young, and food resources to toxic effects that could result in population-level impacts. A VLOS could also affect habitats along extensive areas of coastline that serve as bird nesting colonies, feeding areas, and wintering grounds. Overall, impacts to birds from a VLOS could be **major** depending on the timing, location, and environmental conditions affecting the weathering of the oil.

4.12.9. Coastal and Estuarine Habitats

An overview of shoreline type, oil behavior, and persistence in Cook Inlet and Shelikof Strait is provided in Appendix A, Section A-2.2.2. As described in Section 4.3.9, porosity of the shoreline substrate is an important determinant of impacts from oil spills. Shorelines in upper Cook Inlet are primarily sheltered tidal flats and salt marshes, which are highly sensitive to oil spill impacts; in contrast, shorelines in middle Cook Inlet are characterized by exposed tidal flats that are less sensitive to oiling (NOAA, 2002b). Shoreline types in lower Cook Inlet are more diverse.

As described in Appendix A, Section A-2.2 and Table A.1-2, ESI shoreline types for LSs in Cook Inlet and Shelikof Strait are characterized by approximately 49% exposed rocky shorelines, 31% mixed sand and gravel beaches, 12% gravel beaches, 3% exposed tidal flats, 2% coarse-grained sand beaches, and <1% marshes. Stranded oil may mix deeply (up to a meter) into well-sorted sand and gravel substrates. Because of the important role that oil residence plays in potential affects to coastal and estuarine habitats, the information provided in Section 4.3.9 is repeated here.

Mixed sand and gravel beaches were a shore type particularly affected by the Exxon Valdez Oil Spill (Gundlach et al., 1990), and gravel beaches pose a special problem because of the potential for deep oil burial and the persistence of subsurface oil for decades (Hayes and Michel, 1999; Hayes, Michel, and Fichaut, 1991; Irvine, Mann, and Short, 1999; Michel et al., 1991; Michel and Hayes, 1993a, b; Owens, 1991; Owens and Taylor, 1993). Gravel beaches enhance oil accumulation through burial by accretionary features and the formation of asphalt pavement; the resultant armoring of the gravel beach impedes erosion (Hayes, Michel, and Fichaut, 1991; Michel and Hayes, 1993a,b). Oil persistence also depends on wave energy, with sheltered areas harboring oil for years to decades (Prince, Owens, and Sergy, 2002).

Examination of past spills confirms the long-term persistence of oil in marshes (Gundlach et al., 1990; Reddy et al., 2002; Wang, Gross, and Taylor, 2001).

Cook Inlet and Shelikof Strait shorelines are characterized by high wave exposure and energy, which may accelerate weathering processes or hinder them due to boulders armoring the substrate (Irvine, Mann, and Short, 1999; Short et al., 2007). Some of the coastal environments adjacent to the proposed Lease Sale Area were oiled from the Exxon Valdez Oil Spill. Re-oiling from another spill could affect oil persistence and weathering.

Oil spill persistence on water or on the shoreline can vary widely, depending on the size of the oil spill; the environmental conditions at the time of the spill; the substrate of the shoreline; and, especially in the case of portions of Cook Inlet, ongoing shoreline erosion. The type of oil is a primary determinant of toxicity. Heavy crude oils have a small degree of direct toxicity to plants, whereas light crudes can cause necrosis and plant mortality on contact (Mendelssohn et al., 2012). Even highly toxic refined products such as diesel, if they are weathered enough, will eventually show reduced toxicity, but the less-toxic residuals can still coat vegetation (Mendelssohn et al., 2012). This condition prevents photosynthesis, thereby impairing the assimilation of carbon used for growth and transpiration, which promotes evaporative cooling. The frequency of repetitive oiling of vegetation is an important determinant of the ultimate injury; repetitive oiling depletes the underground nutrient reserves used to generate new shoots (Mendelssohn et al., 2012). The time of the year in which an oil spill occurs also influences the spill’s impacts on vegetation. Spills during colder periods when the plants have a lower metabolism or are dormant have a reduced impact relative to oil exposure during warmer seasons (Alexander and Webb, 1985, as cited in Mendelssohn et al., 2012). However, arguably the most important determinant of severity is whether the oil penetrates the soil and comes into contact with nutrient-absorbing roots and shoot-regenerating rhizomes, as this can cause plant death (Mendelssohn et al., 2012). Perennial marsh plants, which regenerate new aboveground shoots each spring, usually recover from stem and leaf oiling, but oiling of subsurface plant organs more often results in plant death. All plant species are not similarly susceptible to oil; species-specific differences in responses to oil can be dramatic (Lin and Mendelssohn, 1996, as cited in Mendelssohn et al., 2012).

The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on coastal and estuarine habitats are described in the following sections.

4.12.9.1. Phase 1 (Initial Event)

IPFs during this phase would likely cause only negligible, temporary effects on coastal and estuarine habitats, with the exception of habitats proximal to the incident. A blowout could redistribute sediments suspended in the water column and deposited on the seafloor. Localized sediment redistribution would be negligible relative to the amount of coastal and estuarine habitats in Cook Inlet. Additionally, the extreme tidal exchange in Cook Inlet creates extremely turbid water, so it is unlikely that the redistribution of sediment in the water column from a blowout would impact the coastal and estuarine environment. A fire would remain localized, as would response activities at the incident site during this phase. Effects on coastal and estuarine habitats are anticipated to be negligible as the fire would likely never reach the coastline. The localized nature of a sunken rig presents negligible impacts to coastal and estuarine habitats. Petroleum or other chemical compounds may be introduced to the marine environment from a damaged rig. Depending on the chemical properties of the compounds, their localized fate, and efficacy of remediation, impacts of the initial event on coastal and estuarine habitats are anticipated to be negligible.

4.12.9.2. Phase 2 (Offshore Spill)

Adverse effects from offshore oil are not likely to directly affect coastal and estuarine habitats. Most of the adverse effects to coastal and estuarine habitats are anticipated during Phase 3 when oil contacts shorelines.

4.12.9.3. Phase 3 (Onshore Contact)

When oil enters the environment from spills, ruptures, or blowouts, it undergoes continuous compositional changes associated with weathering; thus, freshly spilled oil is the most environmentally significant type of oil (Mendelssohn et al., 2012). Much of Cook Inlet is bordered by extensive intertidal mud and sand flats that grade into equally extensive vegetated tidal and supratidal wetlands (Figure 3.2.6-1). Supratidal, intertidal, and subtidal habitats are an important conduit of energy, nutrients, and pollutants between terrestrial and marine environments; they also provide resources for subsistence, sport, and commercial harvests, and are important for recreational activities such as wildlife viewing and fishing.

As described in Section 4.12.9, marine intertidal habitats range from rocky to unconsolidated (e.g., beaches, sand bars, flats), with extensive tidal marshes and unvegetated tidal flats (Field and Walker, 2003). Oil from a VLOS may adversely impact coastal and estuarine habitats in the proposed Lease Sale Area and surrounding region. Much of what is known about potential impacts from a VLOS to nearshore areas and shorelines stems from research following the Exxon Valdez Oil Spill in Prince William Sound. As described by Mendelssohn at al. (2012), weathered oil initially loses volatile components, which are also the most water-soluble components, and the oil becomes more viscous and more likely to coagulate as opposed to spreading out in a thin film. Over time, weathering continues to change the composition of oil until it degrades in the environment, leaving behind residue. Typically, during weathering, much of the oil (especially heavier oil) will mix with water and emulsify, forming a viscous mixture that is resistant to rapid weathering and more difficult to remediate.

How vegetation responds to petroleum hydrocarbons and the vegetation’s capacity to recover depend on a variety of factors intrinsic to the plant species and specific to the spill event (Mendelssohn et al., 2012). Because spills occur under different chemical, environmental, and biotic conditions, impacts and recovery trajectories can vary greatly and can be difficult to predict (Mendelssohn et al., 2012). The primary determinants of how vegetation responds to petroleum hydrocarbons are (1) the toxicity of the oil, which is depends on the type of oil, the amount of weathering, and the extent of plant coverage; (2) the degree of oil contact with and penetration of the soil; (3) plant species composition; (4) oiling frequency; (5) the season during which the spill occurs; and (6) cleanup activities (Lin and Mendelssohn, 1996; Pezeshki et al., 2000 as cited Mendelssohn et al., 2012).

Subtidal habitats consist of those below the mean lower low water tide line to greater water depths. Communities in nearshore subtidal areas typically are characterized by dense stands of kelp or eelgrass and include various invertebrate species such as amphipods, polychaete worms, snails, clams, sea urchins, and crabs. Subtidal habitats provide shelter and food for an array of nearshore fishes, birds, and marine mammals.

It is estimated that up to 13% of the oil that was spilled during the Exxon Valdez Oil Spill was deposited in subtidal zones. The direct toxicity of the oil as well as subsequent cleanup activities caused changes in the abundance and species composition of plant and animal populations below lower tides. Initial injuries were evident for several oil-sensitive species. Infaunal amphipods, a prominent prey group in subtidal communities, were consistently less abundant at oiled sites than at unoiled sites. Reduced numbers of eelgrass shoots and flowers were also documented and may have resulted from increased turbidity associated with cleanup activities. Two species of sea stars and helmet crabs also were less abundant at oiled sites when compared to unoiled areas. However, stress-tolerant organisms, including polychaete worms, snails, and mussels were more abundant at oiled sites. These species may have benefited from organic enrichment of the area by addition of oil or from reduced competition or predation because more sensitive species were depleted (EVOSTC, 2014b). Details regarding potential impacts of a VLOS on other resources are provided in other sections of this chapter.

Adverse impacts from a VLOS may affect intertidal communities. More than 2,250 km (1,400 mi) of coastline were oiled during the Exxon Valdez Oil Spill in Prince William Sound, on the Kenai and Alaska Peninsulas and in the Kodiak Archipelago. Heavy oiling affected approximately 354 km (220 mi) of this shoreline. It is estimated that 40% to 45% of the 11 million gallons of crude oil spilled by the *Exxon Valdez* washed ashore in the intertidal zone. For months after the spill in 1989, and again in 1990 and 1991, oil and intensive cleanup activities (see Section 4.12.9.4) had significant impacts on the flora and fauna of this environment. Initial impacts to the intertidal zone may occur at all tidal levels and in all types of habitats throughout the oiled area, as this happened in Prince William Sound during the Exxon Valdez Oil Spill (EVOSTC, 2014a).

The presence of oil could prevent or disrupt access to and use of affected areas. Residents and visitors may be displaced or prevented from using coastal and estuarine recreational areas. Other potential effects of a VLOS on the intrinsic value of coastal areas include the following:

- Immediate degradation of coastal aesthetics
- Large amounts of oil coupled with cleanup operations could diminish the experiences offered by coastal parks, refuges, and recreation areas
- Negative public perception regarding the diminished intrinsic and pristine quality of coastal habitats; and
- Oil sheens from hydrocarbons uncovered over time by tidal and storm action could persist and perpetuate the public's perception of degraded environment

The loss of potential use of coastal and estuarine habitats as a result of an offshore spill would range from minor to major depending on the size of the spill.

4.12.9.4. Phase 4 (Spill Response and Cleanup)

If a VLOS resulted in extensive oiling of the waters and tidal areas of Cook Inlet and the surrounding region, it could require intensive cleanup, restoration, and remediation activities conducted by potentially thousands of workers and hundreds of pieces of equipment deployed in the coastal zone. The effort could result in the unprecedented imposition of people, noise, and activity on the area's undeveloped and typically sparsely occupied landscape. Booming and cleanup activities can involve increases in vehicle, vessel, and foot traffic; use of heavy mechanized equipment; and high-pressure washing, all of which can cause damage to the environment and biological communities of coastal and estuarine habitats, particularly if activities are unmonitored. Cleanup attempts, including chemical and physical methods, can be more damaging than the oil itself, with impacts recurring as long as the cleanup continues (Peterson et al., 2003). Cleanup methods used on shorelines contacted by oil could include excavation, hot-water washing, manual cleaning using oil absorbent materials, and placement and recovery of sorbent pads. Manual removal of oil by spill response personnel can break plant shoots, which may do more harm to the vegetation than the oil itself, or they may push oil farther into the soil (Mendelssohn et al., 2012). In addition to mechanical cleanup and recovery activities, additional response strategies such as the use of dispersants could be employed and intentionally introduced into the environment, likely at the sea surface, and applied using aircraft or vessels. Dispersants may have an adverse effect on coastal and estuarine habitats depending on the type of dispersant used and its fate in the coastal ecosystem. Bioremediation could be employed as a strategy to remove or neutralize pollutants using organisms (e.g., microbes that degrade oil). Bioremediation techniques would likely have a negligible effect on coastal and estuarine habitats.

4.12.9.5. Phase 5 (Post-Spill, Long-Term Recovery)

Long-term adverse effects to coastal and estuarine habitats are anticipated from a VLOS. During the Exxon Valdez Oil Spill, the extent and degree of oiling on shorelines decreased rapidly over the first few years after the spill, and it was assumed that remaining oil would be reduced to negligible amounts soon thereafter (Neff et al., 1995). However, observations up to 8 years after the incident indicated that oil remained in intertidal sediments of some beaches (Hayes and Michel, 1999), leading to concerns that lingering oil could continue to have harmful effects on fish and wildlife populations as well as the nearshore ecosystem. Over the long term, coastal and estuarine habitats would experience continued degradation where cleanup efforts were not completely successful.

Prompted by concerns about lingering Exxon Valdez Oil Spill, a study was initiated in 2001 (12 years after the spill) to evaluate the amount and distribution of lingering oil in Prince William Sound. Short et al. (2004) found that surface residues and subsurface oil persisted on some beaches, including the majority of beaches that were classified as heavily or moderately oiled within 4 years of the spill. Surface deposits were highly weathered and largely transformed into asphalt-like material, which was considered to have low toxicity and low bioavailability, and to pose minimal threats to fish and wildlife. However, subsurface oil was liquid and much less weathered than surface residues (Hayes and Michel, 1999), leading to concerns that the subsurface oil might be bioavailable and toxic. Short et al. (2004) estimated that the areal extent of subsurface oil in 2001 was 7.8 ha (19 ac) and the mass of remaining oil was 55,600 kg (61.3 tons), but a subsequent publication considered these to be underestimates, given several factors that would lead to a low bias (Short et al., 2006). For example, subsurface oil was found lower in the intertidal than anticipated, at elevations not sampled during the 2001 effort, and this may have led to an underestimate of approximately 30% (Short et al., 2006). Despite the uncertainty, estimates were under 1% of the amount of oil thought to have originally been stranded on Prince William Sound beaches. The potential effects of lingering oil on wildlife populations are discussed in other sections.

Subsurface oil presumably has been declining in occurrence and extent over time, through disturbance of sediments associated with storm events; foraging by intertidal animals, including sea otters; and other releasing, weathering, and degrading processes. The rate at which attenuation occurs is unknown and presumably becomes progressively lower over time (Integral Consulting, 2006; Short et al., 2004, 2007), with oil persisting longest in areas that are least susceptible to depletion processes (Short et al., 2007). The oil remaining on beaches as a result of the Exxon Valdez Oil Spill is only 0.14% to 0.28% of the volume originally beached, and the decline was most rapid during the first few years (Short et al., 2004). Approximately 2% of the original spill volume of Exxon Valdez oil was estimated to remain on Prince William Sound beaches by fall 1992 (Wolfe et al., 1994, as cited by Short et al., 2004), implying losses of approximately 58% per year during the first 3.5 years. Assuming a density of 0.96 for weathered oil (Bragg and Yang, 1995, as cited in Short et al., 2004), this volume is equivalent to approximately 806,000 kg (88.8 tons). Comparison with the 2001 estimate of 55,600 kg (61.3 tons) implies an annual loss rate of 20% to 26%, substantially slower than anticipated (Boehm, 1982, as cited in Short et al., 2004). Shorelines polluted by oil spills require practical methods for monitoring impacts. The extent of oiling must be monitored to effectively allocate beach protection and clean up resources, to determine persistence, and to assess damages (Short et al., 2004).

4.12.9.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percentage of trajectories from a VLOS contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days during the VLOS release.

4.12.9.7. Conclusion

The potential impacts of a VLOS on coastal and estuarine habitats could be **major** and likely would have long-term effects, although some habitat recovery would be expected in the near-term following an event. After the Exxon Valdez Oil Spill in Prince William Sound, rocky shorelines returned to conditions similar to those observed in unoiled areas. However, large fluctuations in the algal coverage in the oiled areas caused a subsequent alteration in community structure. Lingering oil is still present in some intertidal areas oiled during the 1989 spill. The volume of oil found on beaches in Prince William Sound has declined since the initial event, but a study by Short et al. (2004) suggested the area of oiled beach has probably changed little since 1992. Comparison of subsurface oiling intensities suggests that dispersion after 1992 may not have reduced the oiling intensity enough to reduce the area of visibly oiled beach (Short et al., 2004). Previously, it was assumed that impacts to populations derive almost exclusively from acute mortality, but in the Alaskan coastal ecosystem, unexpected persistence of toxic subsurface oil and chronic exposures, even at sublethal levels, have continued to affect wildlife (Peterson et al., 2003). Oil degrades at varying rates depending on environmental conditions, and subsurface sediments physically protected from disturbance, oxygenation, and photolysis can retain contaminants from partially weathered oil for years (Peterson et al., 2003). Oil can persist beyond a decade in surprising amounts and in toxic forms, be sufficiently bioavailable to induce chronic biological exposures, and have long-term impacts at the population level (Peterson et al., 2003).

4.12.10. Economy and Population

A hypothetical VLOS could generate several thousand direct, indirect, and induced jobs and millions of dollars in earnings and revenues over the short-term. The *Exxon Valdez* spill, which was twice as large as the hypothetical VLOS scenario examined here, generated employment of up to 10,000 workers directly performing cleanup. Smaller numbers continued the cleanup efforts during the summer months annually for several years after the 1989 spill. Additional housing and infrastructure may be needed to support cleanup workers following a VLOS and if so, the Kenai Peninsula Borough would receive property taxes from any additional infrastructure constructed to support the efforts.

As described in Section 4.3.10 for accidental large spills, the effects of a VLOS on the economy and population would depend on several factors, including seasonal conditions during the spill, the level of preparedness and training of response personnel, and the amount and distribution of compensation payments. In addition, any suspension of oil and gas activities following occurrence of the VLOS could adversely affect employment, personal earnings, and revenues that lost future production on state and Federal waters would generate. A VLOS would adversely affect the economics of non- oil and gas activities in the area such as commercial fishing, sport fishing, recreation, and tourism (discussed in other sections). The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1.

4.12.10.1. Phase 1 (Initial Event)

The explosion and fire that would occur during the initial event would have a limited effect on the economy and population. First responders would be mobilized and sent to the site of the explosion to battle the fire, which is projected to last one to two days. This mobilization would require a minor influx of employment and associated earnings. Population would not be affected.

4.12.10.2. Phase 2 (Offshore Spill)

Employment and earnings would increase during this phase, owing to the continued release of oil into offshore waters, the need for response workers and equipment to supplement first responders, and the efforts required for cleanup operations. The numbers of response workers and vessels mobilized during this phase would depend on the spatial extent of oil on the water surface. Increasing space-use conflicts could occur as the number of response vessels increases and if the oil spreads across shipping lanes. In addition, mobilization of response vessels could affect access to and use of dock and port space.

4.12.10.3. Phase 3 (Onshore Contact)

Employment and earnings would continue to increase during this phase. The numbers of workers and onshore infrastructure would begin to increase substantially during this phase as more workers are mobilized for onshore cleanup operations. The number of response vessels would increase to transport workers to and from remote locations for onshore cleanup operations. Space-use conflicts would continue to increase as the number of response vessels increases and the oil spreads. Increasing numbers of response vessels would continue to affect access to and use of dock and port space.

4.12.10.4. Phase 4 (Spill Response and Cleanup)

The increase in employment and earnings would peak during this phase. Potentially thousands of workers could be employed for response and cleanup operations in offshore Federal and state waters and onshore

Federal, state, and private lands. Thus, population would increase at least temporarily. Additional housing and infrastructure might be needed to support the influx of workers. New housing and infrastructure would generate additional property tax revenues.

4.12.10.5. Phase 5 (Post-Spill, Long-Term Recovery)

Employment and earnings from response and cleanup would begin declining from peak levels, and other factors would begin influencing the economy and population during this phase. These factors include reduced availability of environmental resources, contamination, perception of contamination, co-opting of human resources, and psychological distress. Each of these IPFs could have long-term effects on the economy and population in the form of employment, earnings, and revenues.

4.12.10.6. Oil-spill Risk Analysis

The OSRA model results in Appendix A estimate that the percentage of VLOS trajectories could contact as far south as Shelikof Strait and east of Kodiak Island up to 110 days following the initial release.

4.12.10.7. Conclusion

The overall effects of a VLOS on the economy and population are anticipated to be beneficial, long lasting and widespread, and thus **moderate**. The response to a hypothetical VLOS could generate several thousand direct, indirect, and induced jobs and millions of dollars in earnings, revenues, and compensation payments. Employment of cleanup workers would increase rapidly during Phases 2 and 3, then peak during Phase 4. Additional property tax revenues could be generated from additional onshore oil spill response infrastructure and new housing built for spill response workers. A potential decrease in revenues could be experienced as Federal, state, and local government revenues decline from displacement of other oil and gas production. A VLOS would adversely affect the economics of non-oil and gas activities in the area such as commercial fishing (major impacts), sport fishing (major impacts), and recreation and tourism (moderate impacts).

4.12.11. Commercial Fishing

A VLOS could have long-term impacts on commercial fishing. In the unlikely event that a VLOS were to occur in Cook Inlet, the nature and magnitude of impacts to commercial fishing would depend on the timing and location of the incident, the commercial species and life stages present, and the habitats exposed to the spill. Exposure to oil from a VLOS would have similar types of impacts on commercial fishing as accidental spills discussed in Section 4.3.11. However, the size of the affected area and the number of species and individuals likely contacted would increase, and the degree of impact would likely be severe. More fishers could be affected and population-level impacts for harvested species could be incurred. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1.

4.12.11.1. Phase 1 (Initial Event)

The potential IPFs that could affect commercial fishing during this phase include an explosion, a fire, minor increases in vessel and helicopter traffic, and noise from rescue efforts. Owing to the “safety zones” around drilling and production platforms, it is anticipated that relatively few (if any) commercial fishers are likely to be in the immediate vicinity of a structure during an initial explosion; thus, they are unlikely to be directly affected. A limited number of vessels and helicopters would be involved in rescue efforts, resulting in an increase in traffic and noise impacts to commercial fishing in Cook Inlet. Rescue efforts may require additional vessel support that could be provided by nearby commercial fishing communities.

The initial scale of the spill may not be apparent upon the announcement that a VLOS has occurred. However, based on previous experience with the Exxon Valdez Oil Spill and the awareness of potential impacts from the *Deepwater Horizon* oil spill, the concerns and distress levels of commercial fishers in the area over the potential spill impact may escalate. For example, during the initial stages of the

Deepwater Horizon oil spill, the feelings of commercial fishers went from worry to dread as the scale of the Federal and state response surged, media attention grew, the well failed to be sealed, and estimates of the flow rate increased (Austin et al., 2014).

4.12.11.2. Phase 2 (Offshore Spill)

Direct exposure to oil and gas and the loss of access to oil-impacted offshore areas are the critical IPFs that could affect commercial fishing during this phase. Oil in offshore waters of Cook Inlet would be a serious threat to harvested fish and shellfish because of its properties of forming a layer on the sea surface, being present in the water column, and depositing on the seafloor. Contamination of prey organisms of harvested commercial species would be expected to occur, possibly resulting in modified prey abundance and ingestion of contaminated prey items (see Sections 4.3.2, 4.12.4, and 4.12.5 for discussion of potential impacts on lower trophic level organisms, fish, and shellfish, respectively). Commercial fishers may have nets or other fishing gear in the water at the time of a spill, which could become contaminated or irretrievable due to official area closures. Depending on the magnitude of an oil spill, fishing areas could be inaccessible or officially closed, forcing commercial fishers to fish in other, potentially less suitable, locations with potentially more fishers.

Commercial fishing vessels may be recruited by local government agencies or oil companies to provide support for response activities such as skimming, deploying boom, or sampling, which could in turn reduce the level of commercial fishing activities in the region. During the *Deepwater Horizon* oil spill, by the end of the summer after the spill, several thousand commercial fishers were working on spill response and cleanup activities through the Vessels of Opportunity Program and not fishing (Austin et al., 2014).

Once oil has entered the offshore environment, fish could move away from affected areas. Data from the 2002 *Prestige* oil spill, a 380,000-bbl oil spill from an oil tanker that affected more than 800 km (500 mi) of the northwestern Spanish coast, suggest that fish actively moved away from oil-contaminated water. Serrano et al. (2006) observed that in the Spanish coastal region impacted by the oil, hake landings decreased to approximately 10% percent of normal, but hake landings dramatically increased approximately 112 km (70 mi) northeast of the oil-impacted region. Data from the *Prestige* oil spill suggest that decreases in fish landings following the spill were primarily due to fish movement rather than the direct lethal effects of oil. The combination of fish moving away from an area and the reduced level of commercial fishing activity would ultimately result in a net reduction of fish landings in the region. The effects of decreased fishing activity in the region likely would be worse during the summer months because of the increased commercial fishing that occurs in Cook Inlet during that season. Catch reductions could impact the regional seafood processing industry. The timing and location of closures due to the spill could cause a change in the flow of fish to certain processing facilities. Owing to catch reductions and changes in the flow of fish to processing facilities, there would likely be an overall reduction in effort (and income) to processing facilities in the Cook Inlet region.

4.12.11.3. Phase 3 (Onshore Contact)

Direct exposure to oil and gas as well as contamination of habitat and prey resources are the critical IPFs potentially affecting commercial fisheries during this phase. As described in Section 4.12.5, large numbers of fish and shellfish could come into contact with spilled oil along shoreline areas and in estuaries and bays, and they could be severely affected through direct contact with oil, ingestion of contaminated prey, or mortality of prey resources. Contamination could reduce the availability of harvestable fisheries, particularly salmon and herring. Oiling in coastal habitats could result in the oiling of commercial vessels and the restriction of commercial vessels from entering or leaving contaminated ports. Fishing would likely be severely restricted in oiled areas. If fishing in an area near the restricted area, fishers would run the risk of oil fouling their gear. If nets are fouled, they would be rendered useless and would have to be discarded.

4.12.11.4. Phase 4 (Spill Response and Cleanup)

Spill response activities likely would employ multiple commercial fishers and fishing vessels to work on spill cleanup during this phase. Depending on the extent of the spill and the time of the year in which it occurred, cleanup efforts could extend from weeks to months to years. Commercial fishing vessels might be deployed to locate and report oil, skim oil, or deploy booms. Fishers not on vessels to locate, skim oil, or deploy booms might be employed to help with sampling, transporting personnel and equipment, and cleaning beaches. Fishers not working on spill response efforts may continue to fish in areas not closed by the spill. Commercial fishers may be unfamiliar with these new fishing areas, potentially leading to a decrease in catch success. Cook Inlet riptides targeted for drift gillnet fishing may also be areas where oil is concentrated. The continued movement of spilled oil with tides would make it difficult for commercial fishers to track closures and re-openings, avoid fouling of gear and vessels, and identify suitable areas for fishing activities. As described in Section 4.2.14.3, chemical dispersants may be used to promote the oil dispersion process and form smaller oil droplets. Application of dispersants can cause toxic effects in fish and larvae, potentially resulting in population-level impacts and reduction of future harvestable numbers. As described for Phase 2, fishers working on spill response and cleanup activities rather than fishing could reduce the overall catch and flow of fish to processing facilities, which in turn could impact the regional seafood processing industry in the Cook Inlet region.

4.12.11.5. Phase 5 (Post-Spill, Long-Term Recovery)

Persistent contamination (and perception of contamination) is a critical IPF potentially affecting commercial fisheries during this phase. The economic cost of a VLOS to the commercial fishing industry would likely result from fishing closures, catch tainting (real or perceived), and vessel and gear contamination. A VLOS could close the fishery in Cook Inlet for a whole season, resulting in a 100% loss for that year. The average annual value of the Cook Inlet commercial fishery is approximately $41 million (USDOI, MMS, 2003); thus impacts of a lost season could be major. Additional losses could be incurred due to damaged boats and gear. A VLOS would preclude knowledge of what the commercial fishery may have been worth that year had the spill not occurred. The price of fish delivered during the year of the spill and in subsequent years could be adversely affected. Even after the cleanup is completed, fish processing companies might still encounter contaminated fish. While the total volume of fish actually found contaminated after the Exxon Valdez Oil Spill was relatively small (Northern Economics, 1990), processing companies emphasized that the additional work and expense to isolate and discard contaminated fish had a financial impact.

In addition to the initial fishing closures at the time of a VLOS, there is a potential for long-term (5 to 10 years) impacts on the biological health of fisheries resources (see Section 4.12.5). A VLOS may restrict fishery harvest due to lower population numbers or restrict an area from being harvested. Sessile shellfish such as weathervane scallops and razor clams may suffer higher mortality rates and exhibit longer recovery rates compared to more mobile fish species, potentially affecting their population abundance and preventing harvest due to tainting. It is estimated that approximately half of the Pacific herring eggs in Prince William Sound were exposed to oil during the Exxon Valdez Oil Spill, and although survival to hatch was not impacted, there were sublethal effects in newly hatched larvae, reducing the survival from hatch to free-swimming forms (Hose et al., 1996). Genetic damage to Pacific herring from an oil spill may persist in future generations after the spill, and reproductive success maybe low (Hose et al., 1996), likely resulting in a net decrease in available harvestable herring stock in the region.

A significant amount of fish harvested from Cook Inlet is marketed out of state. A VLOS could have long-term impacts on these external markets. A future VLOS, combined with the history of spills in the area (e.g., *Glacier Bay* and *Exxon Valdez*), could alter customers' perceptions of the product. A likely concern of the Cook Inlet fishing industry would be that perception of Cook Inlet's fisheries (e.g., salmon) may be degraded if the area is continually associated with oil spills (Northern Economics, 1990).

The potential decrease in market demand for what is harvested, lack of fish resources to harvest, and declining economic success and uncertainty regarding the litigation process following the spill could increase psychological stress in the commercial fishing community, potentially leading to depression, symptoms characteristics of post-traumatic stress disorder, and a lack of civic cohesiveness, as documented from the Exxon Valdez Oil Spill (Picou and Martin, 2007). A VLOS would have a major long-term impact on resource-dependent commercial fishing communities in the Cook Inlet region.

4.12.11.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percentage trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days following the VLOS. Several other resources can be used as proxies for examining the potential effects on commercial fisheries based on OSRA model estimates of where the oil may go, including lower trophic level organisms (Section 4.12.4), fish and shellfish (Section 4.12.5), and marine mammals (Section 4.12.6). Contamination of demersal fish, shellfish, groundfish, forage fish, and juvenile fish in areas that are contacted by oil can affect commercial fishing owing to potential tainting of harvestable fish, their prey, and their habitat. Many LSs on the west, southwest, and southeast coasts of Cook Inlet contain rivers with anadromous runs that could be adversely affected by contact with oil. These coastal areas are important as launch points for commercial fishing vessels (Homer and Kenai), and the presence of oil near the harbors and river mouths could drastically restrict access to fishing grounds. Oil 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 oil, causing chronic or acute effects, particularly on early life stages. Based on the percent chance of contact from a spill and the areas contacted, the fish species most likely affected include intertidal, estuarine, and nearshore spawning and/or rearing fishes, particularly capelin, Pacific herring, sand lance, and Pacific salmon. In addition, oil contact with anadromous fish and eulachon transiting lower Cook Inlet, out-migrating juvenile salmon entering western Cook Inlet from natal rivers and streams, and Pacific cod, halibut, and walleye pollock in offshore waters in western and southern Cook Inlet could affect severely commercial fishing. Impacts to these populations could have a major effect on commercial fishing because the long-lasting impacts could decrease harvestable fish stocks.

4.12.11.7. Conclusion

Potential impacts to commercial fisheries resulting from a VLOS would be similar to the impacts described in Section 4.3.11 for accidental large oil spills, but differing in the magnitude, extent, and duration of potential affects. Although unlikely, the occurrence of a VLOS in Cook Inlet during spring could result in a 100% economic loss to the Cook Inlet commercial fishing industry for the year because of fishery closures. Losses could continue for 4 years following the spill, generating revenue at a reduced rate. Income from commercial fishing would severely decline immediately after the spill. A decline in income may stem from the spill for years after, as evidenced by changes in average earnings, ex-vessel prices, and limited entry permit values following the Exxon Valdez Oil Spill. However, natural variability in fish returns and other economic factors such as world supply of salmon (wild catch versus farmed), allocation changes (e.g., a reduction in the allocation of Cook Inlet sockeye salmon to commercial fishers), or entry restrictions in certain fisheries, although not directly attributable to the oil spill, might contribute to fluctuations in income post-spill.

A VLOS in winter could limit the extent of closures by the following spring and summer because the effects of the remaining oil on fishes (and perceptions of tainting) would likely be reduced by that time. Winter fishing closures in the areas where the oil spill occurred or oil contacted are possible; however, winter commercial fisheries are deepwater fisheries less likely to be closed, and there are far fewer ongoing commercial fisheries in winter. Therefore, economic losses to the commercial fishing industry due to a VLOS in winter would likely be far less than what would be expected from an identical spill occurring in the spring.

Recovery of commercial fisheries from a VLOS may take decades. The Exxon Valdez Oil Spill severely impacted commercial fishing when oil drifted into Cook Inlet. Commercial fishing was injured from the spill's direct impacts to fish species and through subsequent emergency fishing closures. Fisheries for salmon, herring, crab, shrimp, rockfish and sablefish were closed in 1989 throughout Prince William Sound, Cook Inlet, the outer Kenai coast, Kodiak, and the Alaska Peninsula. In 1990 and thereafter, commercial fishing was reopened, while shrimp and salmon commercial fisheries remained closed in parts of Prince William Sound.

In a 1994 Restoration Plan prepared by the EVOSTC, declines in pink salmon and Pacific herring populations and the reduction in these fisheries were recognized as the greatest contributors to injury of the commercial fishing service in the *Exxon Valdez* spill area (EVOSTC, 2015). A strategy for restoring commercial fishing included funding projects that accelerated fish population recovery, protected and purchased important habitat, and monitored recovery progress. Pink salmon and sockeye salmon recovered from the oil spill by 2002. However, recovery was not considered complete for Pacific herring, a fishery closed for 15 of the 21 years since the spill (EVOSTC, 2015). Such long-term restoration of the industry can take a heavy toll on local communities and industries. In addition to a downturn in population and employment, those who remain may experience an increase in psychological stress levels.

A VLOS could affect nearshore and offshore habitats along extensive areas of Cook Inlet that are important fishing areas utilized by commercial fishers. Overall, impacts to commercial fishing from a VLOS could be **major** depending on the timing and location of the spill and on the environmental conditions that affect oil weathering and degradation.

4.12.12. Subsistence Harvest Patterns

A VLOS could adversely and severely affect subsistence harvest patterns owing to the direct contact of oil with shorelines and resources, or the perception of tainting, which could result in the following:

- Displacement of people from traditional harvest areas
- Displacement of resources
- Competition for resources
- Loss of traditional practices
- Social distress and threats to cultural values and identities
- Undesirability for use from contamination or perceived tainting
- Rendering resources unfit for consumption
- Indirect effects on habitats for prey items, from upriver to offshore
- Reduced numbers of resource species
- Potential changes in traditional diets
- More difficult pursuit of resources resulting in increased subsistence harvester effort; and
- Increased risk or cost of the subsistence effort caused by subsistence harvesters traveling farther to locate and harvest species

Potential effects on subsistence harvest patterns as a result of accidental spills are described in Section 4.3.12. A VLOS during the open-water season could affect subsistence hunting of sea otters, Steller sea lions, and birds; ocean and riverine fishing; harvesting marine invertebrates such as shellfish and crabs, and plants; and beluga whale hunting (if any take is authorized). In winter, a VLOS could affect subsistence harvests of fish and terrestrial animals. Disturbance could result in the extension of subsistence hunting efforts by increasing the miles traveled and by subsistence harvesters making more frequent, longer trips to harvest adequate resources in a season. The potential degradation and loss of subsistence harvest patterns due to a VLOS would cause harvest disruptions throughout the year, but loss of the primary harvest season for fish in summer would have the greatest impact throughout the Cook Inlet watershed and adjacent areas of Kodiak Island and the Alaska Peninsula (Fall et al., 2006). Any of these losses could be severe and thus major for subsistence harvesters. In particular, salmon harvests for subsistence and personal use could be the most sensitive, owing to its principal importance in the annual round of activities for harvesting and sharing resources in the community.

The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on subsistence harvest patterns are described in the following sections.

4.12.12.1. Phase 1 (Initial Event)

Direct impacts on subsistence harvest patterns would likely be localized in the initial phases of the blowout event, but could be widespread. Effects to subsistence harvest patterns from the news and images of the event would likely be traumatic to subsistence harvesters throughout Cook Inlet, Kodiak Island, and the Alaska Peninsula region. This would likely produce increased stress and anxiety over the safety and availability of resources and accessibility to harvest areas. Because many subsistence harvesters also participate in the personal use and commercial fisheries of the region, their concerns about food and economic security would be further increased. Community fears about reduced or contaminated resources, contaminated habitats and harvest areas, reductions in the ability to harvest and distribute traditional foods, and concerns related to general food safety could cause increases in social stressors (USDOI, MMS, 2007).

4.12.12.2. Phase 2 (Offshore Spill)

During this phase, direct contact with oil is the critical IPF potentially affecting subsistence resources. Pollution stemming from an oil spill may contaminate environmental resources, habitats, and food sources and prevent or disrupt access to and use of affected areas. If offshore oil comes in direct contact with migrating or resident fish or marine mammals, harvest practices could be severely curtailed, particularly in terms of subsistence and personal use fishing and beluga whale hunting (if a harvest quota is in place). Persistence of oil in resource habitats could compromise traditional harvest areas and reduce or eliminate access to them.

4.12.12.2.1. Marine Mammals

As described in Section 4.12.6, the effects of a VLOS on beluga whales, sea otters, harbor seals, and Steller sea lions could occur as a result of oiling of skin and fur, inhaling hydrocarbon vapors, ingesting oil, consuming contaminated prey, loss of food sources, and temporary displacement from some feeding areas. These effects could cause injury, death, or displacement, making them unavailable for subsistence harvesting, processing, and distribution. A VLOS contacting areas near Tyonek and upper Cook Inlet could disrupt the beluga whale migration and deprive the community of its primary marine mammal subsistence hunt (if authorized in the future). Loss of harvest opportunities for sea otters, harbor seals, and Steller sea lions would be an incremental loss to subsistence harvest traditions in communities that take some of these marine mammals each year.

4.12.12.2.2. Fish

A VLOS could affect offshore and nearshore fish species in the path of or near the oil through 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 all salmon species; steelhead; some demersal and semidemersal fish (groundfish) such as pollock, herring, eulachon, cod, and halibut; and some shellfish. Subsistence and personal use harvests of fish would be affected to the extent that the offshore spill caused these resources to come in contact with oil, potentially causing death or damage to individuals, and making them undesirable for human consumption. Contamination of the resources or their habitats would cause subsistence harvesters to stop targeting those species voluntarily due to concerns about contamination or due to agency-imposed harvest restrictions. Offshore oil spill response vessels and support could disrupt travel to harvest locations if subsistence harvesters chose to pursue fish in the aftermath of a spill.

4.12.12.2.3. Birds

As described in Section 4.12.8, the potential effects of a VLOS on marine and coastal birds during this phase could be serious. Seabirds and waterfowl would be especially vulnerable during this phase of a VLOS because they spend the majority of their time on the sea surface and often aggregate in dense flocks. Increased bird mortality, contamination of bird prey items, displacement of birds from habitats, and degradation of avian habitats from exposure to oil would have adverse impacts on patterns of subsistence bird harvest.

4.12.12.3. Phase 3 (Onshore Contact)

Potential major impacts to subsistence harvest patterns could occur during this phase, including the following:

- Severe oiling of onshore resource habitats and coastal harvest areas
- Persistent and severe contamination of subsistence resources, resource habitats, and traditional subsistence harvest areas
- Severe curtailment or inability to use traditional food sources due to actual and/or perceived contamination; and
- Severe disruption or prevention of access to harvest areas owing to the presence of oil

Shoreline habitats are of particular importance to subsistence harvesters. In Alaska, oil spill fate and persistence on shorelines have been documented in the 25 years since the *Exxon Valdez* spill released 260,000 bbl of oil in Prince William Sound. Boehm et al. (2014) studied buried subsurface oil and its residues for 20 years after the spill, documenting the following:

- Surface oil was removed rapidly, weathering to inert asphalt and generally observed on boulder/cobble shorelines
- Subsurface oil declined at a rate of approximately 80% per year from 1989 to 1992 and approximately 4% per year after 2001, with residues occurring in small isolated patches; and
- By 2009, most subsurface oil on shorelines was present as light oil residue with minor amounts of scattered, sequestered heavy and moderate oil residues

4.12.12.3.1. Marine Mammals

Harbor seals, Steller sea lions, fur seals, and sea otters would be affected by oil that contacts shorelines serving as haul-outs and rookeries, with adverse effects of oil contamination occurring as described for Phase 2.

4.12.12.3.2. Fish

A VLOS could affect offshore and nearshore fish species in the path of or near the oil through direct (e.g., acute toxicity) or indirect (e.g., shifts in prey availability) effects. 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 could require more than three generations. Onshore contact could impact migrating resources such as anadromous fish due to the chemical constituents of the oil and their potential toxicity immediately affecting fish. This contamination could be present for years, even in apparently cleaned habitats (Boehm et al., 2014).

Depending on the timing, extent, and persistence of a VLOS, some distinct runs of certain species of salmon could be affected. Recovery from this impact may occur as strays from other fish populations colonized the streams after oiled habitats recovered. Local fish stocks would not be available for subsistence harvests for years (see Section 3.3.3). The effects on subsistence uses of fish during the onshore contact phase are similar to those described for Phase 2. The effects on subsistence would be disastrous and severe if a VLOS contacted shorelines used for subsistence setnet and rod-and-reel fisheries used by subsistence harvesters and for personal use. Losses to subsistence-oriented communities would not only be the loss of fish harvests, including marine invertebrates, for many years, but the loss of traditional kinship-based harvesting, processing, and sharing activities that result in a significant portion of the annual subsistence harvest. The psychological and emotional impacts of such losses were documented in the aftermath of the Exxon Valdez Oil Spill (Fall et al., 2006), and similar impacts to subsistence harvesters would be expected to occur in Cook Inlet in the event of a VLOS.

4.12.12.3.3. Birds

As described in Section 4.12.8, oil spills can affect large numbers of birds due to oil toxicity to individual birds, contamination of their prey, and disruptions from cleanup activities. Many bird species important to subsistence harvest communities are associated with coastal areas. Bird eggs are collected by subsistence harvesters, so any decline in numbers or the availability of birds would impact subsistence harvesting of eggs. Bird hunting and egg harvesting primarily occur for Tyonek at locations along Trading Bay south of Granite Point to the McArthur River mouth. For Nanwalek and Port Graham, waterfowl harvesting, marine bird egg harvesting, and hunting occur from Rocky Bay facing Kennedy Entrance as far north and east as the upper reaches of Kachemak Bay. Offshore islands are important use areas for the subsistence harvest of birds and eggs because these areas provide important nesting, molting, and migration habitat for a variety of waterfowl and shorebirds. A VLOS that occurred during periods of peak use by migratory birds could affect large numbers of birds, which could in turn cause major harvest disruptions to subsistence hunters.

4.12.12.3.4. Terrestrial Mammals

As described in Section 4.12.7, terrestrial mammals that use coastal habitats would be affected by this phase of a VLOS. Direct contact with oil, contamination of prey items, loss of foraging areas, and displacement from habitats could have short- and long-term impacts to the health of terrestrial mammals, including moose, deer, black and brown bears, caribou, fox, and wolves. These subsistence species 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; any scavenger species feeding on remains of oiled carcasses could become contaminated (USDOI, MMS, 2007). Impacts to these animals could in turn severely affect subsistence harvest patterns for target species of terrestrial mammals.

4.12.12.4. Phase 4 (Spill Response and Cleanup)

Spill response and cleanup would increase the presence of work crews, boats, aircraft, and associated noise that could displace subsistence species and alter, reduce, or eliminate subsistence harvesters' access to resources in traditional harvest areas, potentially for an entire season or more. Spill cleanup would provide an opportunity for local high-paying work that could displace local hunters from traditional subsistence harvest pursuits. Disturbance to marine mammals, fish, birds, moose, other terrestrial mammals, and marine and terrestrial vegetation would increase during oil spill cleanup activities. The impacts from a VLOS during the spill response and cleanup phase would be similar to those during the onshore contact phase but magnified in duration and geographical extent, and exacerbated by the presence of more vessels, aircraft, skimmers, booms, animal rescue efforts, and beach cleanup personnel. The activities and equipment used during cleanup could result in the displacement of marine mammals, birds, and fish, altering their migration pathways and causing them to avoid areas where they are traditionally harvested. Wildlife resources may become warier and more 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 areas or species, and alter or disrupt the seasonal round of subsistence harvests. The culmination of these potential effects could result in severe disruption of subsistence activities by:

- Increasing the distance harvesters must travel in order to locate and harvest resources
- Increasing the number, duration, and difficulty of trips necessary to harvest enough resources during a season; and
- Increasing the costs for subsistence harvest activities due to the need for more fuel for longer trips, opportunity-cost losses due to the need to stay away from wage employment for longer periods, and other dollar cost impacts

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.

4.12.12.5. Phase 5 (Post-Spill, Long-Term Recovery)

During the post-spill, long-term recovery phase, subsistence patterns could continue to be affected by reduced fish and wildlife populations, contaminated subsistence resources, and degraded subsistence habitat quality or access. Severe impacts to subsistence harvest patterns could occur from the following:

- Unavailability or increased difficulty in obtaining and utilizing subsistence resources
- Long-term contamination of prey resources, habitats, and/or subsistence foods resources stemming from the oil spill
- Alteration of traditional subsistence and use patterns based on the perception that resources are contaminated
- Reduced access to benefits and resources due to co-opting of human resources, funding, and equipment required to study long-term impacts of the spill and facilitate recovery; and
- Psychological, social, and physical distress to subsistence community members due to a decrease in or lack of traditional foods and loss of traditional practices

Subsistence is intertwined with sociocultural systems, community health, and environmental justice concerns discussed in other chapters. Long-term subsistence impacts from a VLOS and its cleanup activities would create a perception of chronic disruptions to subsistence resources and subsistence ways of life, especially for environmental justice communities. Any actual or perceived tainting, especially of fish and marine invertebrates, could cause severe disruptions in harvest patterns. This would likely lead to a breakdown of kinship networks, sharing patterns, and increased social and health stressors in communities.

Participation in spill response and cleanup work by residents of the proposed Lease Sale Area, such as occurred with the Exxon Valdez Oil Spill in 1989, could severely disrupt subsistence harvest patterns and community health and well-being. Participation in cleanup activities could result in the following changes in community members:

- Non-participation in subsistence activities
- Spending of cash surplus from spill response work on material goods or possibly drugs and alcohol

- Cease or not pursue employment because oil spill cleanup wages are higher than average (Aldy, 2014)

After a VLOS, it is expected that considerable stress and anxiety would occur over the loss of subsistence harvest patterns and traditional practices, contamination of resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (e.g., state or Federal bans on consumption of resources), and the need to depend on the knowledge of others about environmental contamination (Fall, 1993). Individuals and communities could be increasingly stressed as they develop modified subsistence harvest patterns by selectively changing harvest areas. If harvest areas were far away in unfamiliar territories, there would be increased safety risks and costs associated with travel and hunting in unfamiliar areas, plus permissions to harvest in other groups' territories would have to be sought and received before travelling to the alternative hunting and fishing 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 be modified or decline. Community sharing of the resources, especially salmon, a culturally significant subsistence resource, could be disrupted, especially if multi-year disruptions of subsistence harvest patterns were to occur.

Effects of long-term recovery could severely impact subsistence harvesters and their extended distribution networks and commercial fishing crew structures and would cause disruptions to Alaska Native 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 also can damage the largely kinship-based 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 (i.e., greater involvement in the cash economy to the detriment of continuing subsistence-oriented cultural practices).

Cleanup after the Exxon Valdez Oil Spill took more than four summers (EVOSTC, 2014a). If a VLOS were to take four summers/seasons or more, this could result in more severe effects on subsistence harvest patterns, sociocultural systems, community health, and environmental justice communities for a much longer time than the period subsistence resources may be measurably contaminated. Widespread uncertainty 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, 2007). In 1989, the Exxon Valdez Oil Spill was considered "ground zero" for sociocultural and psychological impacts from a VLOS (Gill et al., 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 (e.g., 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.
- Lack of ecosystem recovery and resulting lack of subsistence harvests is a factor for chronic psychological stress and community disruption (Gill et al., 2014).

After the Exxon Valdez Oil Spill, subsistence harvests declined between 9% and 77% in 10 Alaska Native villages affected by the spill. By 2003, subsistence harvests increased but were not as high as pre-spill harvests. In 2010, many subsistence species were considered recovered or recovering, but harvest levels were still down; 83% of Alaska Native residents felt that their traditional way of life had been damaged by the spill, and 74% believed that recovery had not occurred since the spill (EVOSTC, 2014). Deflection of resources resulting from the combination of a VLOS and spill response activities could persist beyond the time frame of a single season, perhaps lasting several years, resulting in severe and thus major impacts to subsistence harvest patterns.

4.12.12.6. Oil-spill Risk Analysis

Subsistence resources in Cook Inlet and the surrounding region are represented in the OSRA model by ERAs and GLSs listed in Table A.1-11 of Appendix A. A summary of the highest percentage of VLOS trajectories originating from any of the six LAs and contacting subsistence resources within 110 days during summer and winter is provided in Table 4.12.12-1. The vulnerability of these resources is based on the seasonal use patterns by subsistence resource hunters described in Appendix A, Table A.1-11.

Table 4.12.12-1. Highest Percentage of VLOS Trajectories Contacting Subsistence Resources[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer	Winter
		110 days2	110 days
Environmental Resource Area (ERA)	≥0.5–<6	2 (Tyonek North), 7 (Larsen Bay), 8 (Karluk), 9 (Akhiok)	7 (Larsen Bay), 8 (Karluk), 9 (Akhiok)
	≥6–<25	5 (Port Lyons), 6 (Ouzinke)	3 (Tyonek South), 5 (Port Lyons), 6 (Ouzinke)
	≥25–<50	3 (Tyonek South), 4 (Seldovia, Port Graham, Nanwalek)	4 (Seldovia, Port Graham, Nanwalek)
Grouped Land Segment (GLS)	≥0.5–<6	116 (Chignik, Chignik Lagoon)	--

Notes: -- all percent chances of contact are <0.5.
[1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) is the same as 110 days in both seasons, but the individual results from each LA may not be identical.
Source: Appendix A (Tables A.1-11, A.2-25, A.2-30, A.2-35, A.2-45, A.2-50, and A.2-55). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

Although a VLOS would originate within the proposed Lease Sale Area, effects might be felt by communities far removed from the initial spill location, including communities in the Kodiak Island region and the southern Alaska Peninsula region. Concerns about subsistence harvests and food consumption would be shared by all Dena'ina, Alutiiq, and Unangam (Aleut) and non-Native subsistence communities. Concerns about contaminated subsistence resources in these communities could curtail traditional practices for harvesting, processing, and sharing important subsistence species because all communities would share concerns over the safety of subsistence foods and food products and the health of the subsistence stocks.

A VLOS occurring between March and October would affect ERA 1, the Subsistence Use Area (SUA) for Tyonek (Appendix A, Map A-2a). Beluga whales would be most affected. With the current ban on beluga whale hunting due to its endangered status, a VLOS would certainly harm the remaining animals in the Cook Inlet stock. A VLOS might cause a further decline in the beluga whale population, increasing recovery time. The effects on beluga whale subsistence harvests would be to delay the time when a subsistence harvest might once again be allowed. The longer Tyonek cannot harvest beluga whales, the longer the time when knowledge about hunting, harvesting, butchering, and sharing beluga whales may disappear from the collective memory of beluga hunters from Tyonek (Braund and Huntington, 2011).

A VLOS occurring between March and October would affect ERA 2, the northern SUA for Tyonek, and ERA 3, the southern SUA for Tyonek (Appendix A, Map A-2a). The OSRA model estimates that ERA 2 is contacted by ≤5% of the VLOS trajectories during the summer within 110 days of the initial spill event.

The OSRA model estimates ERA 3 is contacted by ≥25% to <50% of the VLOS trajectories during the summer within 110 days after the spill event and 6% to 24% of the VLOS trajectories during the winter within 110 days after the spill event. Marine resources affected would be Pacific salmon (five species), tomcod, herring, eulachon, harbor seals, beluga whales, and marine invertebrates and plants (e.g., clams and cockles). Fish and other marine resources constitute the majority of wildlife resources harvested by weight and per capita consumption in subsistence communities (Fall, Foster, and Stanek, 1984; Schroeder et al., 1987). A VLOS causing mortality, reduced numbers, and perceived or actual contamination of these resources would be severely disruptive to subsistence harvest patterns.

A VLOS occurring any time during the year would affect ERA 4, the SUA for Seldovia, Port Graham, and Nanwalek (Appendix A, Map A-2a). The OSRA model estimates ERA 3 is contacted by ≥25% to <50% of the VLOS trajectories during the summer within 110 days after the spill event and 6% to 24% of the VLOS trajectories during the winter within 110 days after the spill event. The marine resources affected would include five species of Pacific salmon, halibut, trout, cod, flounder, rockfish, sculpin, herring, clams, crab, bidarkees, octopus, waterfowl, seals, sea lions, bird eggs, seaweed, and kelp (Kenai Peninsula Borough, 1992). Fish and other marine resources constitute the majority of wildlife resources harvested by weight and per capita consumption in subsistence communities (Schroeder et al., 1987; Stanek, 1985). A VLOS causing mortality, reduced numbers, and perceived or actual contamination of these resources would be severely disruptive to subsistence harvest patterns (Merrill and Opheim, 2013).

A VLOS occurring any time during the year would affect the following Kodiak Island communities (Appendix A, Map A-2d): ERA 5, the SUA for Port Lions; ERA 6, the SUA for Ouzinkie; ERA 7, the SUA for Larsen Bay; ERA 8, the SUA for Karluk; ERA 9, the SUA for Akhiok; and ERA 10, the SUA for Old Harbor. The OSRA model estimates ERAs 7, 8, and 9 (Larsen Bay, Karluk, and Akhiok) would be contacted by <5% of the VLOS trajectories during both summer and winter within 110 days of the initial spill event. The OSRA model estimates ERAs 5 and 6 (Port Lions and Ouzinkie) would be contacted by ≥5% to <25% of the VLOS trajectories during both summer and winter within 110 days of the initial spill event. The OSRA model estimates VLOS trajectories would not reach ERA 10 (Old Harbor) at any time after the initial spill event. For all communities, five species of Pacific salmon, halibut, seals, sea lions, clams, and crab would be affected. Fish and other marine resources constitute the majority of wildlife resources harvested by weight and per capita consumption in subsistence communities (Schroeder et al., 1987; Wolfe, Hutchinson-Scarbrough, and Riedel, 2012). A VLOS causing mortality, reduced numbers, and perceived or actual contamination of these resources would be severely disruptive to subsistence harvest patterns. Even though the spill might not reach the Old Harbor SUA, Old Harbor's subsistence harvest patterns could be affected. It is likely that Old Harbor residents would increase their harvest efforts in order to share resources with communities on the north side of Kodiak Island affected by the spill event.

A VLOS occurring between May and October would affect GLS 116, part of the SUA for Chignik Bay and Chignik Lagoon (Appendix A, Map A-4a). GLS 116 is composed of 15 LSs stretched over >225 km (140 mi) of southern Alaska Peninsula coastline, and the immediate inland areas from Cape Igvak at the northern end to Pavlof Bay at the southern end. The OSRA model estimates GLS 116 would be contacted by ≤5% of the VLOS trajectories during the summer within 110 days of the initial spill event. All of the subsistence species would be vulnerable throughout the year, including salmon, halibut, herring, Pacific cod, shellfish, seals, sea lions, sea otters and terrestrial mammals such as caribou, moose, and brown bear (Morris, 1987). Fish and other marine resources constitute the majority of wildlife resources harvested by weight and per capita consumption in subsistence communities (Morris, 1987). A VLOS causing mortality, reduced numbers, and perceived or actual contamination of these resources would be severely disruptive to subsistence harvest patterns.

4.12.12.7. Conclusion

Effects from a VLOS, such as food tainting and cleanup disturbance, could occur after a spill event during the onshore contact and spill response and cleanup phases. An oil spill affecting marine resources and habitats, fish, birds, marine invertebrates, harbor seals, Steller sea lions, and beluga whales could taint resources that together are essential to the subsistence way of life. Concerns about tainting apply to all marine resources and could cause short-term avoidance effects in some subsistence communities. Loss of species utilized for subsistence purposes would reduce their local availability for harvest. Oil spill cleanup activities could produce additional effects on subsistence activities, such as causing displacement of subsistence resources and difficulty for harvesters accessing traditional use areas.

Long-term recovery of resources and subsistence harvest practices is likely. Harvesting, processing, and sharing of subsistence resources would continue, although potentially hampered due to the degree that these resources were actually contaminated or perceived as contaminated. Concerns about tainting and contamination, actual or perceived, could seriously curtail the traditional practices of harvesting, processing, and sharing resources in communities near the spill or contacted coastlines. Curtailment of these practices could threaten important cultural and spiritual rituals in these communities and affect the health and well-being of Alaska Native residents living in environmental justice communities. In the case of long-term or extended contamination, harvests would cease until such time that local subsistence harvesters perceived the resources to be safe. Any loss of subsistence harvest patterns would be harmful to subsistence-dependent communities in many ways, impacting not only the subsistence cultures, but also health, economics, sociocultural systems, and environmental justice communities. As with the Exxon Valdez Oil Spill, the instantaneous nature and the magnitude of the event would not permit opportunistic “stocking up” of available subsistence resources (USDOI, MMS, 2007).

If a VLOS occurred and affected any of the five species of Pacific salmon or other marine resources or their habitat, it could taint these culturally significant resources. Any actual or perceived disruption or tainting of salmon and other marine resources from oil spills and any other resulting impacts from a VLOS during the spring migration, summer feeding, and natal stream spawning could disrupt subsistence fishing for an entire season, even though fish might still be available. Even if fish were available for harvest during the early spring, summer, and fall harvests, concerns of tainting could make salmon and other marine resources undesirable and alter or stop the subsistence harvests in Tyonek, Nanwalek, Seldovia, and Port Graham and the personal use dipnet fisheries on the salmon streams of the Kenai Peninsula at the Kenai River, Anchor River, Kasilof River, and Kachemak Bay area. Concerns over loss of cultural practices and community health when consuming traditional fish and marine-derived subsistence foods could persist for many years past any actual harvest disruption. These same concerns would extend to the harvest of intertidal resources (e.g., marine invertebrates and plants) and terrestrial animals. The alteration or cessation of salmon harvests and the hunting of other subsistence resources due to contact with oil from a VLOS, actual or perceived tainting, and alterations and disruptions to subsistence harvests lasting multiple seasons would be severe and have **major** adverse effects on subsistence harvest patterns.

4.12.13. Sociocultural Systems

A VLOS could cause adverse effects to sociocultural systems, particularly for smaller, subsistence-oriented communities in which residents are economically, culturally, and socially dependent on marine resources, commercial fishing, and subsistence fishing (Braund and Behnke, 1980). Distress may result from direct effects on resources that are used in some way by local residents (i.e., subsistence, tourism, recreation, and elements of quality of life) and from the effects of extended spill response and cleanup activities on communities. As described in Section 4.12.12 for subsistence harvest patterns, these effects can result in increased demands on community services and increased stress on local communities.

In communities where social, cultural, and economic lives and livelihoods are carried out in a specific place and based on natural resources from the land and waters, people experience losses that coincide with changes to natural resources that occur on the landscape (Maldonado, Colombi, and Pandya, 2014). As concerns arise over the tainting of subsistence resources such as fish, marine mammals, birds, and marine invertebrates from an oil spill, traditional practices of harvesting, sharing, and processing subsistence resources could be severely curtailed in the short term, and overall effects from these sources could be expected to adversely and severely disrupt current sociocultural systems (USDOI, MMS, 2007). Events that disrupt the ability of community residents to harvest preferred resources could have multiple effects on the community as a whole, depending on the severity and duration of the disruption (Braund and Moorehead, 2009). Examples of the potential effects include lower harvests; fewer preferred resources harvested; additional time, money, and effort required to harvest resources due to lowered efficiencies; increased food transfers from other communities; and increased Federal transfer payments such as the Supplemental Nutrition Assistance Program.

4.12.13.1. Phase 1 (Initial Event)

Initial impacts from a VLOS could cause severe psychological and social distresses to sociocultural systems during this phase. Pre-existing stress created by fears of a large oil spill (pervasive in community testimonies and scoping meetings) would be triggered. 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.

Impact Assessment, Inc. (2001) found that for Alaska Native peoples, early impacts of the Exxon Valdez Oil Spill were compounded by the sense of “fear” about resource safety, the “alienation” from culturally valued activities, and continuing litigation, all contributing to lingering psychological impacts from the spill. Some of the reported impacts may have been mitigated by the general post-spill recovery in subsistence harvest resources and practices (USDOI, BLM and MMS, 2003; USDOI, MMS, 2003). Recent research has identified that directly after an oil spill, fear, community ties, and employment were direct indicators of mental health, physical health, well-being, and greater community attachment can lower feelings of fear and community disruptions (Cope, 2012).

4.12.13.2. Phase 2 (Offshore Spill)

Contamination of resources and habitats used by local communities and the loss of access to those habitats could severely impact sociocultural systems during this phase. Similar to the effects of stress described in Phase 1, community members are likely to have fears about cleanup response capabilities or a lack of spill cleanup expertise. Exposure of offshore subsistence harvest areas to spilled oil could result in area closures, limiting or prohibiting subsistence harvests and community activities in those areas. Stress and fear precipitated by a mistrust of outside government institutions could persist long-term and would extend beyond the spill area.

4.12.13.3. Phase 3 (Onshore Contact)

Disruption of subsistence harvest resources from a VLOS would have predictable and severe consequences and could affect all aspects of sociocultural systems (social organization, cultural values, and institutional organization) (Luton, 1985). The primary effect would be the depletion of each Alaska Native family’s stored foods and the possibility of harvesting less preferred resources. Concerns over tainting would create a reluctance to consume traditional resources. Immediately after the Exxon Valdez Oil Spill and continuing into early 1990, Alaska Native peoples decreased their harvests of wild resources and relied on preserved foods harvested before the spill (Human Relations Area Files, Inc., 1994a, b, c). By winter 1991, the Alaska Natives’ normal harvesting activities had begun to resume, but the proportions of wild foods in their diets were below those of 1989.

The harvest of less-preferred resources can require more time, labor, and equipment than harvest practices normally used to get preferred resources. As described in Section 4.12.12, if a VLOS affected a traditional harvest area, subsistence harvesters 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).

4.12.13.4. Phase 4 (Spill Response and Cleanup)

Employment of community members during spill response and cleanup could disrupt subsistence harvest activities for an entire season or longer, which could severely affect sociocultural systems by altering harvest patterns. Thousands of temporary local jobs could be created, and increases in wages could have sudden and severe effects, including inflation in the region and deterrence of Alaska Native residents away from their normal subsistence activities. Cleanup is unlikely to add permanent population to any of the subsistence-oriented communities, and in the short-term, administrators and workers would likely live in separate enclaves during cleanup activities. However, employment of local residents could alter normal subsistence practices and impose stress on local village infrastructure by drawing local workers away from village service jobs (Impact Assessment, Inc., 1998; USDOI, BLM, 2012).

4.12.13.5. Phase 5 (Post-Spill, Long-Term Recovery)

As described in Section 4.3.13 for accidental spills, the long-term effects of a VLOS could be felt in three areas of sociocultural systems: social organization, cultural values, and institutions.

Disruption of social organization, including a decreased emphasis on the importance of family, cooperation, and sharing, could result from multi-year modifications to subsistence harvest patterns and community activities, especially with respect to salmon harvesting, processing, and distribution. Picou et al. (1992) showed that 18 months following the Exxon Valdez Oil Spill, residents of Cordova had experienced long-term negative social effects, including disruption to work roles and increased personal stress, particularly in the case of fishers. Social well-being could be affected in the long term as health issues, safety concerns, and risk factors persist or increase. As increased demands are placed on household networks and as available resources are redistributed, village residents may need to make greater numbers of requests for traditional foods, first to nearby communities and then to those beyond (i.e., Kenai, Homer, Anchorage, and other cities inside and outside Alaska). These requests, in turn, could accelerate depletion of the resources held by the contributing networks. Spending may increase to purchase food to make up for the shortfall in harvested foods. Changes in workforce and demography could occur through consolidation of households to save money, including placement of dependents with relatives beyond the village, out-migration of wage earners in search of employment, and over-extension of household credit lines. These effects could deplete the pool of available subsistence producers, severely affecting the structure of households and reducing the stability of families and communities (USDOI, BLM, 2012).

Cultural values could be altered through the disruption of sharing networks, subsistence task groups, and fishing crew structures; a decreasing emphasis on subsistence as a livelihood; and an increased emphasis on wage employment, individualism, and entrepreneurial activity. Modification of traditional practices could result in increased risks associated with travel, hunting in unfamiliar areas, and increasing costs to hunt. Associated cultural activities such as the First Salmon celebration and the sharing of subsistence resources could be adversely and severely altered or disrupted (USDOI, BLM, 2012). If community leaders and/or subsistence providers are unable to fulfill their roles, community stability could be affected, potentially resulting in a decrease in spiritual teaching and knowledge transfer (which typically takes place during hunting). Others in the community who use materials in objects of cultural expression and trade, an important source of supplemental income to some households, could experience severe levels of stress. Other pressures could include increased drug and alcohol abuse, a breakdown in family ties, and a weakening of social well-being, leading to additional stresses on health and social services available to community members.

Institutional organizations could be affected by persistent stress on individuals and disruptions to social patterns for those who work in city governments and tribal governments (USDOI, MMS, 2007). Increases in requests for temporary assistance resulting from the combination of sociocultural effects over time can lead to an increase in corrective legal and social action, eroding cooperation (USDOI, BLM, 2012). Following the Exxon Valdez Oil Spill, institutional effects included additional burdens on local governments, the disruption of existing community plans and programs, strain on local officials, difficulty dealing with Exxon Corporation, community conflicts, and disruptions of customary habits. There were changes in communities related to patterns of behavior, emotional effects, and stress-related disorders from confronting environmental degradation and violation of community values (Endter-Wada, 1992).

Following the Exxon Valdez Oil Spill, stress resulted from the perceived loss of control over individual and institutional environments and secondary episodes such as litigation, which produced secrecy over information, uncertainty over outcomes, and community segmentation (Smythe, 1990). Attempts to mitigate social effects often were 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., 1990a, 1998; Human Relations Area Files, Inc., 1994a,b,c). However, there was resurgence in traditional strategies for responding to resource shortages. Following the spill, this resurgence resulted in an increase in sharing and a renewal and strengthening of social connections with extended family members and friends. It also resulted in a cooperative approach to subsistence activities within and between the most affected communities (USDOI, BLM, 2012).

True restoration of environmental damage includes the reestablishment of a social equilibrium between the biophysical environment and the human community (Fall and Utermohle, 1999; Field et al., 1999; Nighswander and Peacock, 1999; Picou and Gill, 1996). Since 1995, subsistence restoration resulting from the Exxon Valdez Oil Spill has improved by taking a more comprehensive approach by partnering with local communities and by linking scientific methodologies with traditional knowledge (Fall and Utermohle, 1999; USDOI, MMS, 2007).

4.12.13.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percentage of trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days of the VLOS release. Impacts of oil contact on subsistence resources discussed in Section 4.12.12 are direct indicators of impacts to sociocultural systems.

4.12.13.7. Conclusion

The effects of a VLOS could have 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, BLM, 2012; USDOI, MMS, 2003, 2007).

Research of the long-term effects of the Exxon Valdez Oil Spill by Fall et al. (2001a) and Impact Assessment, Inc. (2001) identified the effects likely to be realized from a VLOS:

- Communities highly dependent on subsistence foods would be most vulnerable to the effects from an oil spill. In these communities, self-identities and family life are largely organized around seasonal harvest distribution and use of foods, and cultural survival is tied to the traditional use of wild foods.
- 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.
- The 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 could be severe without necessarily leading to permanent sociocultural losses such as loss of cultural knowledge, skills, or values within families.

- Concerns about potential sociocultural effects may lead to intensification of economic and cultural revitalization as a social movement in communities.
- During cleanup, the efforts of village residents would be redirected from subsistence activities to wage-sector employment and redirected between cash and non-cash activities.
- 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.
- No major permanent demographic changes would necessarily occur.
- The possible purchase of ANCSA lands for conservation areas would cause loss to the Alaska Native land base, while creating new opportunities for income and investment.

These and other studies indicate that disruptions to social patterns were long lasting but not permanent after the Exxon Valdez Oil Spill. The social structure of villages, towns, and cities, while affected by the spill, continued and persisted in the aftermath of the spill (Cohen, 1993; Fall, 1992; Fall and Utermohle, 1995; Gill et al., 2014; Human Relations Area Files, Inc., 1994a, b, c; Impact Assessment, Inc., 1990a,b; Picou et al., 1992).

4.12.14. Public and Community Health

A VLOS could have long lasting and widespread and thus moderate impacts on public and community health depending on the type of spill, volume released, time of year, location of the spill, and environmental conditions at the time of the spill. Exposure to oil from a VLOS would have similar types of impacts on public and community health as accidental spills discussed in Section 4.3.14. The size of the affected area and the number of required response personnel would increase, and thus public and community health could be impacted on a larger scale. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1.

4.12.14.1. Phase 1 (Initial Event)

Explosion and fire could affect public and community health during this phase and would be short-term and localized. This would most likely result in moderate psychological distress related to concerns about the spill, the possible injury of community members, and economic and environmental repercussions of the initial event. An explosion and subsequent fire would be a localized event, but potentially dangerous to any persons in the immediate vicinity such as oil and gas employees working on the rig. Additionally, any emergency response personnel would be at risk and need to exercise caution in containing the fire and other potentially hazardous elements. It is anticipated that an explosion and subsequent fires would be short-lived, and being offshore, relatively isolated from the general public.

In terms of the larger context, psychological distress resulting from the initial event could affect public health, with locals having concerns over contamination or the perception of contamination, anticipated impacts to local natural resources such as fish and shellfish (Section 4.12.5), marine mammals (Section 4.12.6), and marine and coastal birds (Section 4.12.8). Distress would result from public and community fears of potential impacts to businesses (e.g., commercial fisheries described Section 4.12.11 and recreation and tourism described in Section 4.12.15) and impacts to aspects of way of life (e.g., subsistence activities described in Section 4.12.12 and sociocultural systems described Section 4.12.13). As noted in Section 4.12.13, pre-existing stress created by fears of a very large oil spill (pervasive in community testimonies and scoping meetings) would be triggered. Concerns of local communities include being inundated during spill response and cleanup with outsiders who disrupt local cultural continuity, damage to the environment, having to engage in oil spill litigation, and contamination of subsistence foods. For example, the Exxon Valdez Oil Spill had severe social effects. Many individuals, whether directly involved or viewing the spill on television, were saddened by the environmental damage and felt that an important public trust had been broken. These feelings, together with dissatisfaction with the results of early cleanup efforts, gave rise to popular sentiment in favor of every possible cleanup and mitigation effort regardless of cost, effectiveness, or possible negative consequences (Shaw, 2002).

4.12.14.2. Phase 2 (Offshore Spill)

Contact with oil, subsequent contamination, and loss of access to affected areas used for subsistence purposes could have long lasting and widespread effects on public and community health during the offshore spill phase. During this phase, a large amount of oil could be at the sea surface, in the water column, and on the seafloor, affecting water quality (as described in Section 4.12.2), depending on the specifics of the spill. Offshore oil would come in contact with natural resources and potentially impact various levels of the trophic web such as lower trophic level organisms (Section 4.12.4), fish and shellfish (Section 4.12.5), marine mammals (Section 4.12.6), and marine and coastal birds (Section 4.12.8), resulting in the contamination of food resources for animals and humans. Oil contact and contamination could cause moderate impacts to public and community health if contaminated resources were consumed by individuals. Loss of access to key areas of activity, subsistence, or recreation because of oil exposure could lead to moderately impact public and community health. For example, Alaska Native peoples in rural areas rely more heavily on subsistence harvesting for their diet. Loss of access would increase community stressors, potentially increase spending on food items, and could decrease the nutritional health of individuals owing to the consumption of more packaged foods. The magnitude of this effect would be a function of the scale and duration of the spill. Potential impacts to subsistence harvesting from a VLOS are specifically addressed in Section 4.12.12.

4.12.14.3. Phase 3 (Onshore Contact)

Similar to the preceding phase of a VLOS, contact with oil, subsequent contamination, and the loss of access to affected areas are the critical IPFs potentially affecting public and community health. Resources closer to shore as well as terrestrial resources could be affected. For example, mussels are an important subsistence species, and as filter feeders could be affected by contamination in the water column. Such contamination entering the food web onshore and offshore could result in short- and long-term, minor to moderate effects to public and community health.

4.12.14.4. Phase 4 (Spill Response and Cleanup)

During the spill response and cleanup phase, dispersant use, *in situ* burning, and use of local and regional resources could affect public and community health. Chemical dispersants could be employed as a response strategy to minimize the impact of spilled oil. The use of dispersants is a controversial subject. Dispersants can cause ecological damage, and some studies have shown that the dispersant can increase the exposure of aquatic resources such as fish to the toxic components of oil through increased uptake of PAHs (Ramachandran et al., 2004). If such affected fish were captured and consumed, this could directly impact public and community health. In certain cases, *in situ* burning may be used as a technique for cleanup and disposal of spilled crude or diesel oil. The effects of *in situ* burning are the same as for an accidental fire as described previously. If performed offshore, the effects would be relatively isolated. Depending on wind conditions, resultant smoke and particulates could have minor to moderate effects on public and community health.

Local and regional public health resources would be increasingly used and potentially stressed due to the influx of additional response workers from outside the immediate area arriving to conduct cleanup activities. An increase in population would result, at least temporarily, which could strain existing regional health response capabilities, depending on the scale and location of effects of the spill. Spill cleanup workers could face potential hazards from oil byproducts, dispersants, detergents, and degreasers. Drowning, heat illness, cold exposure, falls, and encounters with wildlife pose potential hazards to cleanup workers, which can further strain existing regional health response capabilities. Additionally, outside workers may introduce pathogens and social conflicts to the local Alaska Native population.

4.12.14.5. Phase 5 (Post-Spill, Long-Term Recovery)

Unavailability of resources, resource contamination or perception of contamination, use of local and regional resources, and psychological and social distress could result during this phase of a VLOS. These Impacts could moderately affect public and community health. As described in Phase 2, there may be loss of access to environmental resources, and food resources may become unavailable or more difficult to access or use. Depending on the severity of the spill and resulting impacts, resource availability may persist in the long term and be widespread. For example, Pacific herring is an ecologically important species and central to the diet of many birds, fish (including commercially caught fish consumed by humans), and marine mammals in Alaska. The Prince William Sound Pacific herring population collapsed 4 years after the Exxon Valdez Oil Spill, resulting in speculation by many that the spill caused the crash and its continued impairment 25 years after the spill (Shigenaka, 2014). Contamination at the trophic (i.e., food web) level from a VLOS could have long-term and widespread effects on resources, depending on the type of resource and level of contamination. For example, studies conducted on mussels (an important food source for animals and humans) in Prince William Sound found PAH concentrations above control levels for more than 3 years following the spill (Shigenaka, 2014).

Physical impacts could persist until the majority of oil is removed by cleanup operations. Unfortunately, where tourism or fisheries are concerned, the consequences are more long-lived due to the effects of negative publicity and persistent public perception of tainting. Such perceptions can be long lasting and widespread, which can further contribute to other impacts to public health over the long term, such as psychological and social distress. Some of these effects may last years after the cleanup operations have been completed.

The influx of additional response workers from outside the immediate area could result in an increase in population that could continue long-term with extended cleanup, remediation, and monitoring activities, potentially straining local and regional community support capabilities, including health systems. As noted in Section 4.12.10, the *Exxon Valdez* spill, which was twice as large as the hypothetical VLOS scenario examined here, involved up to 10,000 workers directly performing cleanup activities. Smaller numbers continued the cleanup efforts during the summer months for several years after the 1989 spill.

4.12.14.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percent of trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days of the VLOS release.

4.12.14.7. Conclusion

The effects of a VLOS on public and community health are anticipated to be **moderate**. The initial spill would cause localized but dangerous conditions to people in the immediate vicinity of the spill, with the potential for fire and explosions of the oil source. Over time, spilled oil from a VLOS could lead to reduced availability of environmental resources, long-lasting and widespread disruptions to subsistence activities, contamination of traditional foods, perception of contamination, and psychological distress. These impacts could adversely affect public and community health for the long term and could be widespread in the proposed Lease Sale Area.

4.12.15. Recreation, Tourism, and Visual Resources

As described in Section 4.3.15 for accidental large spills, effects of a VLOS on recreation and tourism and visual resources would depend on the location of the incident, transport of the oil, and season of the spill's occurrence. Recreational areas that a VLOS is most likely to affect are those located along the shoreline. Some of the effects of spills on coastal recreational resources might include altering the use of recreational lands or waters and reducing the quality of the recreational experience or viewsheds. A

VLOS could oil the water and shoreline and cause changes to the scenery, behavior of wildlife, or patterns of visitor use.

Oil spill persistence on water or on the shoreline can vary widely, depending on the ultimate size of the oil spill, the environmental conditions at the time of the spill, the substrate of the shoreline and, in the case of portions of Cook Inlet, whether the shoreline is eroding. Oil clings to certain types of shoreline, including marshes, peat, fine-grained sediments, and armored cobbled shores, and tends to weather very slowly in these environments. Shoreline oiling in recreational areas, the persistence of that oil, and cleanup efforts would cause long lasting, widespread, and adverse effects on recreation and tourism and visual resources.

BOEM modeled large oils spills in Cook Inlet and determined the length of coastline that could be oiled would vary by the size of the spill and time of year. Modeling suggests that a 1,700-bbl spill would oil 18 to 24 km (11 to 15 mi) of coastline, and a 5,100-bbl spill would oil 31 to 40 km (19 to 25 mi) of coastline. A VLOS would likely oil a greater length of coastline.

The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1.

4.12.15.1. Phase 1 (Initial Event)

Effects of the initial event on recreation and tourism would depend on the time of year the incident occurs. The potential for recreationists and tourists to be exposed to a fire or explosion on an offshore rig would be less during the winter compared to the summer vacation season. Even during the summer, however, effects of the initial event would be limited to recreationists and tourists present within viewing distance of the rig, fire, and smoke during the incident.

Although loss of well control, blowout, and potential explosion and fire associated with this phase of a VLOS would cause temporary direct and perceived visual impacts in the area, the catastrophic nature of this phase would likely involve concerns far more important than visual impacts. Due to the temporary nature of the direct visual impact, it is unlikely that the visual impact would be of particular concern. Potential effects on public health are discussed in Section 4.12.14.

In general, while the event would affect recreationists and tourists who view it in person, the initial event itself is likely to have a localized and short-term, and thus minor effect on this resource, regardless of the time of year that it occurs because of the limited duration (two days) and limited direct exposure to recreationists and tourists.

4.12.15.2. Phase 2 (Offshore Spill)

The effects of the offshore spill phase on recreation and tourism would depend a variety of factors, including the location, time of year, and weather conditions at the time of the spill. In particular, time of year is a principal factor; the potential for recreationists and tourists to be exposed to the offshore spill phase would be lower during the winter compared to the summer. Oil on the sea surface and pollution of water resources resulting from an offshore oil spill could create a visual impact from certain elevated locations where the spill is evident. A distinct unnatural shift in the hue of the water would likely change the visual perception of the environment. Visual impacts may temporarily diminish the public enjoyment from specific locations throughout the area, but once contained and managed, those impacts would diminish. Waterborne recreational activities such as boating and waterborne wildlife viewing and sightseeing would be directly affected as the oil forces private or commercial recreational users to divert from the area to avoid the oil. The effects of this displacement on recreation and tourism would increase over time as the oil spreads and waterborne recreational activities are displaced from more areas. The effects on waterborne recreational activities could become long lasting and widespread, and thus moderate as the affected area increases in size.

4.12.15.3. Phase 3 (Onshore Contact)

Oil that reaches the shoreline could cause moderate to major effects to coastal-dependent and coastal-enhanced recreational and tourism values. The extent of the effects would depend on the areas where oil makes contact with the shoreline. Oiling of shorelines in recreational areas would affect recreation and tourism more than oiling of shorelines along privately owned lands. In addition, the length of oiled shoreline will increase over time as the spill continues. The length of shoreline likely to be affected and the potential for effects to recreation and tourism would be widespread.

Oil that reaches the shorelines of recreational areas would have the greatest potential to adversely affect recreation and tourism and visual resources. The presence of oil on the shoreline of a recreational area would reduce the attractiveness of that area to recreationists and tourists. As long as oil is present, those portions of the recreational areas would likely be closed to visitors.

Widespread presence of oil on beaches and slicks on the water surface (along with non-visual olfactory cues) would tarnish the pristine nature of the landscape and directly impact its appeal. However, these impacts would be temporary in nature and would diminish following containment and cleanup. After the initial cleanup was completed and the areas were reopened, some recreationists and tourists may still avoid visiting those areas for an extended time until they are confident that the areas have recovered from the spill. In addition to causing recreationists and tourists to avoid oiled areas, the VLOS could affect nearby recreational areas that are not oiled. Areas not affected by oiling likely would experience an increase in human use. Following the Exxon Valdez Oil Spill, unoiled areas became more heavily used as recreational activities were displaced from oiled areas.

Overall, oiling of the shorelines of recreational areas from a VLOS would reduce the quality of the recreational experience and alter patterns of recreational use. Recreational areas with oiled shorelines would be affected directly whereas nearby recreational areas with unoiled shorelines could be affected indirectly. These effects could be long-term and widespread.

4.12.15.4. Phase 4 (Spill Response and Cleanup)

Spill response and cleanup would temporarily compound visual impacts associated with a VLOS scenario. As mentioned previously, in a perceived pristine environment, massive cleanup efforts may include burning of oil, extensive aerial and vessel support, use of dispersants, animal recovery and rescue, deployment of large oil absorbent booms, and beach cleanup efforts, all of which would detract from the visual enjoyment of scenic resources. While this activity would likely produce minor visual impacts, they would be temporary in nature and over time the visual environment would fully recover from the impacts of such activities.

Waterborne recreational activities such as recreational marine boating, wildlife viewing, and sightseeing would be directly affected as the area with oil present is closed to facilitate the spill response. Space-use conflicts could arise if vessels engaged in spill response activities force private or commercial recreational visitors to divert from the oiled area to avoid conflicts, and no other areas nearby offer similar recreational opportunities. Waterborne activities in portions of the proposed Lease Sale Area and surrounding region that adjoin the spill area would be indirectly affected by the noise, increased level of activity, and increased number of vessels, which would reduce the quality of a recreational experience.

The effects on recreation and tourism would increase over time as the oil spreads, spill response activities increase, and more of the area is closed to recreational and tourism activities. The effects on waterborne recreational activities would last at least as long as the spill response is ongoing. In the case of an early summer occurrence of a VLOS, the effects on recreation and tourism could extend through the entire summer season and beyond. Consequently, the effects of the spill response phase on recreation and tourism could be long lasting and widespread.

4.12.15.5. Phase 5 (Post-Spill, Long-Term Recovery)

During the long-term recovery after a VLOS event, visual resources will not be adversely impacted as any impacts will be mitigated by cleanup efforts. However, the post-spill recovery phase could result in adverse effects if the public perceives recreational, tourism, and scenic values of the affected area and its surroundings to be diminished, and that perception (real or not) changes the public's preference for using an area. Thus, long-term spill response and cleanup efforts could moderately affect recreation and tourism if the area gains the reputation as being environmentally degraded and that perception results in a decline in coastal-dependent and coastal-enhanced recreation and tourism. Ongoing coverage of cleanup efforts by the media could contribute to a general perception of environmental degradation that would discourage visitation to the area.

The perception of environmental degradation could vary between Alaskans and non-Alaskans. Local Alaskans are more likely to return to recreational areas before non-Alaskans. Telephone interviews conducted after the Exxon Valdez Oil Spill with Alaskans who recreated in the spill area before and after the spill indicated that oil remaining on the beaches did not deter them from using the area. Although sightings of seabirds, seals, and sea lions were diminished, the possible presence of residual oil apparently had little or no effect on recreational activities at a variety of recreational areas, including the Lake Clark and Katmai National Park coastlines.

In contrast, non-Alaskan recreationists and tourists are less likely than Alaskans to return to oiled recreational areas as quickly (McDowell Group, 1990). A larger investment of money and time would be needed to travel the long distances to the area. Justifying that investment would be more difficult and could discourage recreationists and tourists if they perceive the environment to be degraded following a VLOS. The effects of the post-spill recovery phase on recreation and tourism could be moderate and long-term. The ultimate effects would depend on a variety of factors, including the locations and extent of shoreline oiling and cleanup efforts.

4.12.15.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percentage of trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days of the VLOS release. BOEM's OSRA modeling suggests a VLOS would likely reach the shoreline of at least some recreational areas within the proposed Lease Sale Area. The percent of trajectories contacting the shoreline varies with the specific location and source of the spill. The OSRA model estimates that shorelines in GLS 128 (Lake Clark National Park and Preserve) and the GLS 127 (Alaska Maritime National Wildlife Refuge) have the highest percent of trajectories contacting shore. For example, the overall annual percent of trajectories contacting the shorelines of these two recreational areas ranges from approximately 20% within 1 day to >50% within 10 days. The OSRA model estimates a 49% to 58% percent of trajectories contacting GLS 127 or 128 within 30 or 110 days, during the annual season. OSRA modeling also estimates that the shorelines of Katmai National Park, Kenai Alaska State Recreation Management Areas, and Kodiak National Wildlife Refuge have 5% to 18% percent of trajectories contacting. Table 4.12.18-1 provides further detail on the percent trajectories contacting other Areas of Special Concern.

4.12.15.7. Conclusion

Overall, the effects of an unlikely VLOS on recreation and tourism and visual resources are anticipated to be **moderate**. The primary concern would be the effects on coastal-dependent and coastal-enhanced recreational and tourism and scenic values. Although OSRA results suggest that the percentage of VLOS trajectories contacting most LSs in recreational areas is ≤0.5% to <6%, it is notably higher for a few areas, such as Lake Clark National Park and Preserve and Alaska Maritime NWR. Although these effects would be primarily limited to areas where oil makes contact with the shoreline, a VLOS could result in long lasting and widespread perceptions of environmental degradation in the area. Real or perceived, this perception could discourage many visitors to the area for an extended time after occurrence of a VLOS.

4.12.16. Sport Fishing

The intrinsic value of sport fishing in Cook Inlet is a function of the pleasure derived from the fishing experience, its value as a food source, and the economic contributions that sport fishing brings to the region. Sport fishing contributes greatly to the regional economy of lower Cook Inlet through spending on travel, equipment, and supplies; by creating jobs; and by generating Federal, state, and local tax revenues. In 2007, 1.2 million angler days were recorded in the Cook Inlet region (ADFG, 2005). Forty percent of the angler days were by non-residents, demonstrating that the value of the Cook Inlet region for recreational angling extends far beyond the State of Alaska. Direct expenditures for sport fishing in Cook Inlet in 2007 totaled more than $730 million. The ADFG (2005) estimates that sport fishing was responsible for an additional $828 million in economic output, $279 million in regional income, and approximately 8,000 jobs in the Cook Inlet area. These dollar amounts account for direct expenditures and indirect impacts (i.e., ripple effects of dollars coursing through a region's economy). The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1.

4.12.16.1. Phase 1 (Initial Event)

During Phase 1, the potential IPFs that could affect sport fishing include an explosion, fire, increases in response vessel traffic, and noise from these efforts (also described for commercial fisheries in Section 4.12.11). Owing to the "safety zones" around drilling and production platforms, it is anticipated that relatively few (if any) sport fishers will be in the immediate vicinity of a structure during an initial explosion; thus, they would be unlikely to be directly affected. A limited number of vessels and helicopters would be involved in rescue efforts, resulting in an increase in traffic and noise impacts on sport fishing in Cook Inlet. Depending on the home port of response vessels, short-term impacts to the availability of port facilities for use by the sport fishing industry may occur. These impacts are discussed further in Phases 2 to 4 of the hypothetical VLOS scenario.

4.12.16.2. Phase 2 (Offshore Spill)

Direct exposure to oil and gas and the loss of access to oil-impacted offshore areas are the critical IPFs that could affect the sport fishing industry during this phase. The presence of oil in offshore waters of Cook Inlet would limit access to and transit of these waters by sport fishing vessels. Depending on the severity of the VLOS, sport fishers may be able to initially avoid oil in offshore waters. However, as a spill continued for up to 80 days, it is assumed that sport fishing areas would be severely restricted. The presence of oil in the water could contaminate fishing gear, which could further restrict fishing activities. These effects likely would be worse during the summer because of the much larger number of sport fishing charters operating during the seasonal fish migrations. As described in Section 4.12.11 for commercial fisheries, fish could move away from affected areas as a result of exposure to oil. Fish tainting (and perceptions of tainting) could impact recreational fishing (Section 4.12.15), including the hire of sport fishing charters by residents and out-of-state tourists.

4.12.16.3. Phase 3 (Onshore Contact)

Direct contamination of coastal areas and sport fishing resources through contact with oil and loss of access to coastal resource areas due to the presence of oil are the critical IPFs potentially affecting sport fishing during this phase. Contamination of shoreline areas and nearshore benthic habitats could affect the prey resources of sport fish species. The length of oiled shoreline will increase over time as the spill continues. The intensity of oiling of particular shorelines could increase. The location of the incident will affect the length of time between the release and onshore contact, providing time for oil to be weathered, dispersed, and/or recovered before reaching the shoreline. With onshore contact, it is likely that most, if not all, sport fishing activities would cease for the season. An oil spill of this magnitude would most likely result in the closure of ports in Homer, Kenai, and elsewhere along the west side of the Kenai Peninsula to all non-spill response vessels. The owners of vessels, charters, and harbor facilities that are contacted by spilled oil could suffer economic losses owing to contaminated fishing gear and reduced usage of the sport fishing resource. Oiled vessels and gear would need to be cleaned or replaced, potentially resulting in additional economic impacts to sport fishing charter operators. Public perception of oil spill damage, real or perceived, as documented during the aftermath of the *Exxon Valdez* spill would diminish the number of sport fishers (Picou and Martin, 2007). Sport fishers likely would cease operations, or where possible, target alternate fishing grounds until the quality of the fishing experience, real or perceived, in the spill area returned to pre-spill conditions. Depending on the timing of the VLOS with respect to sport fishing seasons, the sport fishing industry could lose up to an entire year's worth of revenue.

4.12.16.4. Phase 4 (Spill Response and Cleanup)

The primary critical IPF potentially affecting the sport fishing industry during this phase is the ongoing loss of access to resource areas, which could essentially shut down the industry. Sport fishing charter captains may hire out their boats for cleanup operations to help offset losses from the closed sport fishing season. For example, during the *Deepwater Horizon* oil spill, owners of marinas and offshore vessel charters were well situated to participate in the Vessels of Opportunity Program. Charter boat captains, deckhands, and those involved in water-based recreation and tourism often went to work for the program or provided maritime transport of researchers and media personnel (Austin et al., 2014). Vessels and equipment may be damaged during spill response and cleanup efforts, and the return to sport fishing may be delayed for months or the entire season in highly affected areas.

4.12.16.5. Phase 5 (Post-Spill, Long-Term Recovery)

As described in Section 4.12.11 for commercial fishing, persistent contamination (and perception of contamination) is a critical IPF potentially affecting sport fishing during this phase. The economic cost of a VLOS to the sport fishing industry would likely result from fishing closures, fish tainting (real or perceived), and gear contamination. The loss of access to fishing areas through the presence of oil or through contamination of the resource would be severe and could shut down the Cook Inlet sport fishing industry for a year or longer. Other indirect effects such as persistence of oil on shorelines could persist for many years. In the aftermath of the Exxon Valdez Oil Spill, sport fishing and related recreation, while slow, rebounded faster than other resources and industries directly impacted from the spill. Studies indicate that in the year following the spill, sport fishing revenues had the potential to decline by 50% or more from pre-spill activity (Carson and Hanemann, 1992). However, in subsequent years, sport fishing angler days rebounded quickly to pre-spill levels.

4.12.16.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percentage of trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days of the VLOS release. As described in Section 4.12.11 for commercial fishing, several other resources can be used as proxies for examining the potential effects on sport fisheries based on OSRA model estimates of where the oil may go, including lower trophic level organisms (Section 4.12.4), fish and shellfish (Section 4.12.5), and marine mammals (Section 4.12.6). Contamination of demersal fish, shellfish, groundfish, forage fish, and juvenile fish in areas that are contacted by oil can affect sport fishing, owing to potential tainting of harvestable fish, their prey, and their habitat. Many LSs on the west, southwest, and southeast coasts of Cook Inlet contain rivers with anadromous runs that could be adversely affected by contact with oil. These coastal areas are important as launch points for sport fishing vessels (Homer and Kenai), and the presence of oil near the harbors and river mouths could restrict access to sport fishing grounds and impede the launching of sport fishing vessels from shore.

4.12.16.7. Conclusion

In the unlikely event of a VLOS in Cook Inlet, it is estimated that **major** impacts would occur to the sport fishing industry. It could eliminate sport fishing in the region for a year or more and generate revenue at a reduced rate for two or more years following the spill. Sport fisheries were closed in 1989 as a result of the Exxon Valdez Oil Spill when oil drifted into Cook Inlet. Sport fishing for salmon and halibut in Cook Inlet and in other areas where the oil spread for only one season resumed in 1990 and thereafter. Based on the total expenditures by all sport fishers in lower and middle Cook Inlet directly attributable to saltwater halibut and salmon fishing, and fishing in the coastal rivers and streams flowing into Cook Inlet, it is estimated that up to 1,200,000 person-days of fishing could be lost during the first post-spill year (based on 60% of fishing trips by non-residents and 40% by Alaska residents) (ADFG, 2005). It is estimated that approximately $730 million could be lost by the sport fishing industry and related industries in one year, which could have a severe impact on the local economy of southeast Alaska.

4.12.17. Archaeological and Historic Resources

A VLOS and subsequent cleanup could impact archaeological and historic resources in Cook Inlet and along the adjacent coastline. Impacts may be direct, indirect, or a combination of the two. Protection of archaeological and historic resources from a VLOS requires knowledge of their location, condition, nature, and extent prior to impact; however, much of the Cook Inlet basin and its coastline have not been systematically surveyed for archaeological sites, making resources located there especially vulnerable. Some response groups have compiled known site data in a form useful for mitigation during an emergency response (Wooley et al., 1997). This work includes information about portions of lower Cook Inlet in the vicinity of Kodiak Island. Additional archaeological site data can be found in “The Cook Inlet GRS Public Information Homepage,” a map-based website that provides response strategies to protect specific sensitive areas within Cook Inlet from oil impacts (State of Alaska Division of Spill Prevention and Response, 2011). Data coverage for the basin stretches from Anchorage in the north to the waters immediately north and west of the Barren Islands. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1. The adverse effects of these IPFs that could result during each phase on archaeological and historic resources are described in the following sections.

4.12.17.1. Phase 1 (Initial Event)

Offshore archaeological resources that are located in close proximity to a blowout could be impacted during the initial phase of a VLOS. Impacts could consist of seafloor disturbances resulting from the drastic redistribution of sediments during an explosion or destruction from the sinking of an offshore rig or platform. Redistribution of sediments could result in burial of a nearby submerged site of archaeological importance. A submerged shipwreck, aircraft, artifact, or exposed cultural material associated with a historic or prehistoric site may be displaced from its original location, be physically damaged, or lose information related to the article’s construction or social history. Sediment redistribution may also affect buried prehistoric sites by destruction of artifacts and site features as well as by disturbance of the stratigraphic context of the site. Although not all possible locations of shipwrecks and prehistoric paleo-landforms in Cook Inlet may be known, the potential of a well or structure being located close enough to damage or bury a known archaeological or historic resources, such as a shipwreck, is low given the survey requirements for exploration and development activities (USDOI, BOEM, 2015f). BOEM would use the information acquired through these surveys to ensure that physical impacts to archaeological and historic resources are avoided. These measures would also protect historic and prehistoric archaeological resources from potential impacts of a catastrophic blowout as would be experienced during a VLOS.

4.12.17.2. Phase 2 (Offshore Spill)

IPFs that could affect archaeological and historic resources during this phase include contact with oil and contamination. As noted in Section 4.3.17, some components of the spill might be expected to adhere to

PM, which could eventually reach the seafloor and impact a shipwreck, aircraft site, or an exposed prehistoric site. A study of deep-water coral communities following the *Deepwater Horizon* oil spill in the Gulf of Mexico (White et al., 2012) may provide insight on the level of impacts to be expected on submerged archaeological sites. That study, which examined 11 coral sites 3 to 4 months after the well was capped, noted that coral at all sites more than 20 km (11 nmi) from the incident site were healthy, while one site 11 km (6 nmi) southwest of the incident site (at a depth of 1,370 m (4,495 ft)) exhibited signs of tissue loss, bleaching, and a covering of flocculent materials (White et al., 2012). Analysis of the flocculate indicated that the material contained oil spilled from the wellsite. Based on this study, it is possible that archaeological resources in Cook Inlet could be similarly coated by oil-laced flocculates resulting from a VLOS.

The effects of such a coating on the integrity and stability of an archaeological site such as a shipwreck or submerged aircraft are largely unknown. Exposed materials, whether elements of the hull, cargo, or other associated debris, are typically colonized by corals and other organisms. Once a site is covered by these organisms, it achieves a state of equilibrium and is protected from further deterioration. Oil from a VLOS may destabilize this environment, causing a die-off of the biota protecting the site and increasing the potential for degradation. Terrestrial studies by Ejechi (2003) on wood in oil-contaminated soils in Nigeria showed that while the oil initially had a positive effect in retarding deterioration, the long-term effects of contamination indicated an increase in deterioration. As part of the *Deepwater Horizon* response, BOEM is currently sponsoring a study examining how oil, dispersed oil, and chemical dispersants used during the cleanup effort have interacted with and become incorporated into select wooden and steel-hulled shipwreck sites, the surrounding seafloor, and the resident biota (MBAC, 2015). While studies are currently underway to determine the intensity and duration of the impacts of a VLOS on archaeological and historic sites, preliminary indications are that the intensity of the impact is high, in that the oil will be visible and is known to cause deleterious impacts to benthic communities that inhabit wreck sites (White et al., 2012).

4.12.17.3. Phase 3 (Onshore Contact)

As with potential impacts from accidental small and large oil spills described in Section 4.3.17, coastal and intertidal archaeological resources can be affected by oil originating from a VLOS. Gross crude oil contamination of shorelines could conceal intertidal sites. Oil saturation of organic materials, including artifacts, can preclude accurate dating by radiometric methods (because of their extreme age, crude oils are deficient in ^{14}C, and thus can skew dating results)(Wooley and Haggarty, 2013). Other long-term effects of oil contamination of artifacts and archaeological sediments have not been identified. However, large areas of Cook Inlet, particularly the western shore, have never been systematically surveyed. The magnitude of the impact would depend on the significance and uniqueness of the archaeological information lost. Duration of this impact is potentially long-term, as described by Exxon Valdez Oil Spill monitoring studies (Reger et al., 2000).

4.12.17.4. Phase 4 (Spill Response and Cleanup)

Archaeological and historic resources may be further impacted during the response and cleanup phase of a VLOS. Activities associated with this phase are expected to last for the duration of the spill event (110 days). Response to an offshore VLOS will involve the use of many vessels during cleanup activities. While anchoring of vessels could disturb the seafloor and any known or unknown archaeological resources, damage is unlikely as vessels operating offshore will most likely employ dynamic-positioning rather than anchoring to stay on station during the cleanup. However, should anchoring be necessary, the potential impacts to known and unknown submerged resources would be high as multiple anchors would be employed to keep a vessel in position. Furthermore, as during the *Deepwater Horizon* oil spill, multiple vessel decontamination stations would be employed in shallow water in the vicinity of port entrances and inland waterways (USDOI, BOEM, 2011b). Vessel mooring is typically favored for shallow-water operations. As a consequence, anchoring of these decontamination stations could impact known and unknown archaeological resources through physical damage to a submerged shipwreck, aircraft, or prehistoric artifacts. Impacts are expected to be localized. Intensity of the damage may vary according to degree of impact. Duration may be long-term as the impact could irreparably damage an archaeological or historical resource.

The response effort will also include the drilling of a relief well to terminate the flow of oil into the environment. Drilling activities would be similar to those employed during the exploration phase of operation and include the use of MODUs. These drilling platforms may be dynamically positioned or moored directly to the seafloor. Anchoring a MODU and drilling a relief well might physically damage known and unknown archaeological resources (USDOI, BOEM, 2011b). Damage and potential impacts would be similar to those noted earlier.

Chemicals employed during the cleanup effort could impact archaeological and historic sites. Research conducted by the Naval Research Laboratory on the effect of one dispersant, COREXIT® EC9500A, revealed that at prescribed concentrations, the viability of hydrocarbon-degrading microbial communities was significantly reduced while the non-hydrocarbon-degrading species proliferated (Hamdan and Fulmer, 2011). The effect of dispersants on the microbial organisms that have a role in degrading historic shipwrecks is still largely unknown. Another study conducted by Church et al. (2007) on World War II shipwrecks in the northern Gulf of Mexico documented the activity of microbial organisms on steel-hulled vessels. The release of millions of gallons of oil and large amounts of dispersants during and following a VLOS into a water body may accelerate or retard the activity of microbial organisms on submerged shipwrecks. The researchers noted that further study was needed to assess the range of impacts from a VLOS and its associated cleanup activities on wood- and steel-hulled shipwrecks. Impacts are expected to be localized, affecting the immediate structure and the organisms that may contribute to the deterioration of submerged sites. Intensity can be expected to be high as dispersants could accelerate the degradation process. Duration of the impact may be long-term as acceleration of the decay process could irreparably damage an archaeological or historical resource.

As with potential impacts from accidental small and large oil spills discussed in Section 4.3.17, the greatest potential impact to coastal and intertidal archaeological resources from a VLOS event would likely not be from the oil itself, but from subsequent cleanup activities (Dekin et al., 1993; Wooley and Haggarty, 2013). Cleanup activities could impact beached shipwrecks 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. Heavy oiling conditions could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Exposure of undocumented sites increases the potential for archaeological sites to be recognized, resulting in the site having a higher chance of being vandalized. Unauthorized collection of artifacts by cleanup crew members is a concern, albeit one that can be mitigated with effective training and supervision. Effects to archaeological resources during the Exxon Valdez Oil Spill were due to physical disturbance from cleanup equipment and to vandalism by cleanup workers (Dekin et al., 1993; Wooley and Haggarty, 2013). Regardless, researchers concluded that <3% of the archaeological resources within the spill area suffered any significant effects.

4.12.17.5. Phase 5 (Post-Spill, Long-Term Recovery)

Historic shipwrecks, submerged aircraft, and archaeological sites are unique nonrenewable resources. Damages caused by a VLOS and its cleanup would be irreversible and may result in the loss of the resource and the information it may contain. The long-term effects of a VLOS to archaeological and historic resources are unknown, but preliminary indications suggest the effects could alter the surrounding site dynamics and increase degradation (Church et al., 2007). Studies are currently underway to explore the impact of catastrophic spills and their cleanup on historic shipwrecks in the Gulf of Mexico (MBAC, 2015).

4.12.17.6. Oil-spill Risk Analysis

The OSRA model results in Appendix A estimate that the percent of trajectories from a VLOS could contact as far south as Shelikof Strait and east of Kodiak Island within 110 days of the initial release. As described in Section 4.3.17 for large oil spills, archaeological resources such as historic shipwrecks, aircraft, and artifacts may be found anywhere within the area under consideration. Submerged shipwrecks, aircraft, and prehistoric sites located in the proposed Lease Sale Area (Figure 3.3.8-1) and those located in the vicinity of the hypothetical LAs (Appendix A, Map A-5) are at most risk of being impacted. Refined oil spills are expected to remain mostly on the surface and weather fairly quickly. As a consequence, the chances of a refined oil spill impacting a shipwreck or prehistoric site would be very remote. Crude oil, on the other hand, contains heavier components that can persist longer in the local environment. The longer crude remains as a coherent slick, the greater the likelihood it will adhere to PM and sink to the seafloor, potentially oiling an exposed shipwreck or prehistoric site. Due to the high-energy environment of Cook Inlet, the longer crude oil remains in the water column, the greater the chances it will be dispersed with any portions reaching the seafloor being in low concentrations. Archaeological sites in ERAs beyond the extents of the LAs are expected to be little impacted during a spill event.

4.12.17.7. Conclusion

In the case of a VLOS, some impacts on submerged shipwrecks, aircraft, and prehistoric sites as well as coastal historic and prehistoric archaeological resources would be expected. The magnitude and severity of the impacts would depend on the timing, size, location, and duration of the oil spill; the length of time the oil persists in the environment; and the presence of archaeological resources in the affected area. Because Cook Inlet is a fairly narrow body of water, oil spills are likely to contact shorelines and potentially impact submerged and subaerial archaeological and historic resources near and on shore. Damage associated with oil spills reaching coastal archaeological resources could include contamination, physical damage from equipment and cleanup crews, and looting. While following proper procedures and cleanup protocols developed during the *Exxon Valdez* and *Deepwater Horizon* events would mitigate most impacts, some impacts may still result in the loss of information. As a result, the potential impacts of a VLOS in Cook Inlet on archaeological and historic resources could be **major**.

4.12.18. Areas of Special Concern

Cook Inlet includes lands designated by the Alaska National Interest Lands Conservations Act of 1980 as units of the National Park, National Wildlife Refuge, National Forest, Wild and Scenic Rivers, and National Wilderness Preservation systems (P.L. 96-487). Within the proposed Lease Sale Area, there are lands managed by the NPS, USFWS, and U.S. Forest Service, including MPAs, NERRs, NOAA-designated critical habitat areas, and several state resources managed by the ADF&G.

These Areas of Special Concern could be severely impacted by a VLOS. Lands with coastlines that are adjacent to and in the vicinity of the proposed Lease Sale Area are likely to have a higher probability of being impacted by oil and gas activities and are therefore discussed in greater detail. Lands managed by the NPS include Parks, Monuments, Preserves, Historic Areas, and designated Wild and Scenic Rivers. There are three National Parks (Katmai, Lake Clark, and Kenai Fjords) and one National Monument (Aniakchak) that are adjacent or nearby the proposed Lease Sale Area. The NERR System is a partnership between NOAA and the coastal states. Kachemak Bay NERR is the only NERR in the region and is located approximately 241 km (150 mi) south of Anchorage, encompassing a total area of 1,505 km^2 (581 mi^2).

The NWR system in Alaska is a network of refuge lands and waters managed by the USFWS for the conservation of fish and wildlife, provision of subsistence uses, and protection of water quantity and quality. There are six NWRs located adjacent to the proposed Lease Sale Area. The Chugach National Forest covers portions of Prince William Sound, the Kenai Peninsula, and the Copper River Delta, and it is the closest National Forest to the proposed Lease Sale Area. It encompasses 27,958 km^2 (10,794.6 mi^2); includes extensive shorelines, glaciers, forests, and rivers supporting numerous avian, mammalian, and other marine species; provides shorebird habitat; and supports a large bald eagle population (USDA, U.S. Forest Service, 2015).

As described in Section 3.3.9, within and contiguous with Cook Inlet, the State of Alaska manages 14 Areas of Special Concern, including Recreational Areas, State Parks, and Critical Habitat Areas. Each of these resource areas are managed with the goals of conserving and restoring fish and wildlife habitat, and providing the public with natural areas for recreational activities. The potential impacts of a large oil spill on these areas are described in Section 4.3.18. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1.

4.12.18.1. Phase 1 (Initial Event)

Potential impacts from an explosion could initially cause adverse effects on Areas of Special Concern during this phase. The severity of the impact would be determined by the location and severity of the explosion. Direct impacts on Areas of Special Concern could occur primarily as impacts to water quality (described in Section 4.12.2) and benthic resources that are important components of coastal habitats (e.g., kelp beds, seagrass, intertidal mudflats, beaches, and salt marsh as described in Section 4.12.9). If an explosion were to occur within or near an Area of Special Concern there could be a major impact on the recreational and subsistence values and availability of Areas of Special Concern to Alaska Native populations and the general public.

4.12.18.2. Phase 2 (Offshore Spill)

As described for Phase 1, impacts of an offshore oil spill could affect Areas of Special Concern as potential impacts to water and air quality, benthic resources, and coastal habitats contacted by the offshore oil during Phase 2. The magnitude and duration of impacts would depend on the spill location and size, and environmental conditions at the time of the spill.

4.12.18.3. Phase 3 (Onshore Contact)

The greatest potential for severe ecological, food web-level impacts to marine and coastal Areas of Special Concern would be associated with oil from a VLOS reaching and oiling the coastal habitats of Areas of Special Concern within Cook Inlet or the surrounding region. In the unlikely event of a VLOS, impacts to water quality, and coastal habitats of Cook Inlet would be major. A VLOS could present severe and sustained degradation of water quality and a reduction in the ecological viability of the coastal marine and intertidal affected habitats. Observations of previous oil spills indicated that intertidal habitats (e.g., marsh, rocky intertidal, tidally exposed seagrass, intertidal flats, kelp canopy habitats) were at a higher risk of oiling and received higher concentrations of oil than subtidal habitats (Ballou et al., 1987). Intertidal habitats would be highly vulnerable to oil that reaches the coastline, and repeated influxes of oil may further contaminate intertidal surfaces with each subsequent tidal cycle. Because of the wide tidal range, extensive areas of shoreline habitat may be affected by a spill.

As described in Section 4.12.9 for estuarine and coastal habitats, highly sensitive shoreline habitats include marshes, sheltered tidal flats, and sheltered rocky shores (NOAA, 1994). The vulnerability of intertidal habitats is generally rated as highest for vegetated wetlands (Hayes et al., 1993b; NOAA 1994, 2000) and semipermeable substrates that are sheltered from wave energy and strong tidal currents. Oil contacting these habitats is less likely to be removed by physical cleanup processes.

Sheltered and low-energy beaches are highly sensitive to an oil spill. On sheltered beaches, heavy oiling left for long periods can form asphalt pavements relatively resistant to weathering (Hayes et al., 1992). Coastal wetlands in sheltered areas such as bays and lagoons that are not exposed to strong water circulation or wave activity would be expected to retain oil longer with longer-lasting and potentially severe effects on biota (Culbertson et al., 2008).

A VLOS could have catastrophic affects in Critical Habitat Areas such as Clam Gulch and Fox River Flats. In worst-case scenarios, these habitats could take decades to recover from an oil spill. Impacts could persist for years because of the low median temperatures of subarctic Cook Inlet. Additionally, sheltered intertidal areas like Cook Inlet are particularly slow to recover from spills (Prince, Owens, and Sergy, 2002). If a VLOS were to occur near an Area of Special Concern, there could be major impacts to the coastal habitat with concomitant impacts to the recreational and subsistence values and availability of Areas of Special Concern to the Alaska Native populations and the general public.

4.12.18.4. Phase 4 (Spill Response and Cleanup)

If a VLOS resulted in extensive oiling of the waters and tidelands of Cook Inlet and the surrounding region, it could require intensive cleanup, restoration, and remediation activities. Potential impacts to Areas of Special Concern involve increased vessel traffic, noise, and routine discharges. Most response vessels will be the same vessels that are routinely utilized as oil and gas supply vessels. These vessels would affect water quality through the permitted release of routine discharges and air emissions. The increased activity could contribute to the accelerated erosion of sediments along unprotected shorelines within an Area of Special Concern by vessel-induced waves. This wave activity could be minimized by maintaining reduced vessel speeds in the vicinity of sensitive habitats whenever possible during the spill response and cleanup phase of a VLOS. The increase in marine operations and cleanup activities could impact wildlife that utilizes the Area of Special Concern, impacting the natural behavioral patterns of the resident and migratory populations. Potential impacts of cleanup activities in sensitive coastal habitats are described in Section 4.12.9.4 and would be relevant if these activities occurred in Areas of Special Concern. The spill response and cleanup phase near and possibly within Areas of Special Concern could have a major impact on the coastal habitat with concomitant impacts to the recreational and subsistence values and availability of the Areas of Special Concern to Alaska Native populations and the general public.

4.12.18.5. Phase 5 (Post-Spill, Long-Term Recovery)

In the unlikely event that a VLOS were to occur in Cook Inlet, the nature and magnitude of impacts to coastal and estuarine habitats would depend on a number of variables, including the volume of crude oil reaching the shoreline, time of year, type of habitat affected, and distribution of species within the affected area. A VLOS could result in the severe degradation of water resources and fouling of coastal habitats from crude oil washing ashore. The proposed Lease Sale Area is unlike any other OCS Planning Area in that it is almost entirely surrounded by coastal habitat, and contact of spilled oil with coastal resources is likely. Currents and tides within Cook Inlet could transport oil or other materials to coastal habitats far from the spill site. Habitats along the western shoreline of Cook Inlet and along Shelikof Strait would have the greatest likelihood of contact from spills within the proposed Lease Sale Area, while the eastern shoreline would have a lower potential for contamination from oil spills (USDOI, MMS, 2003). A spill under ice or in rapidly freezing or broken ice would be more difficult to remediate, and weathering would occur much more slowly. Under these conditions, oil could be transported considerable distances and contact coastal habitats during spring break up.

The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, and species sensitivity (Hayes et al., 1992; Hoff, 1995). Spilled oil remaining in wetlands after cleanup degrades naturally by weathering processes and biodegradation via microbial communities in the sediment. Studies indicate that full recolonization of sheltered rocky shorelines in Cook Inlet may require 5 to 10 years (Highsmith et al., 2001); however, other studies have indicated that recovery in some intertidal and shallow subtidal habitats takes more than a decade (EVOSTC, 2010a; Peterson, 2000).

Oil spill response activities could impact coastal and estuarine habitats as described in Section 4.12.9. Negative impacts to the coastal and estuarine environment could result from the sudden influx of emergency response personnel, ground vehicles, and other related operations. Spill cleanup actions might damage coastal habitats in Areas of Special Concern through trampling of vegetation, incorporating oil deeper into substrates, increasing erosion, and inadvertently removing of plants or sediments, all of which could have long-term effects (Hoff, 1995). Effective low-impact cleanup actions could include bioremediation, low-pressure flushing, or use of chemical cleaners (Hoff, 1995).

4.12.18.6. Oil-spill Risk Analysis

National Parks, NWRs, State Parks, State Game Reserves, and Critical Habitat Areas are special areas in Cook Inlet and the surrounding region. These Areas of Special Concern are represented in the OSRA model by LSs and GLSs listed in Table A.1-15 of Appendix A. A summary of the highest percentage of VLOS trajectories originating from any of the six LAs contacting these Areas of Special Concern within 110 days during summer and winter is provided in Table 4.12.18-1. The Areas of Special Concern with the highest percentage of VLOS trajectories (≥50%) contacting them are located on the western shore of the proposed Lease Sale Area and include six different areas.

Table 4.12-3. Highest Percentage of VLOS Trajectories Contacting Areas of Special Concern[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer 110 days[2]		Winter 110 days	
Land Segment (LS)	≥0.5–<6	38	Kalgin Island CHA	38	Kalgin Island CHA
	≥6–<25	35	Tuxedni Refuge	35	Tuxedni Refuge
Grouped Land Segment (GLS)	≥0.5–<6	113, 114, 122, 130, 139, 143, 158, 161, 164	Alaska Peninsula NWR, AMNWR SW Shelikof/GOA, Becharof NWR, Redoubt Bay CHA, Kachemak Bay SWP, AMNWR W Outer Kenai/GOA, AMNWR W Kodiak/Shelikof, AMNWR E Kodiak/GOA, Afognak State Park	114, 122, 130, 139, 143, 158, 161, 164	AMNWR SW Shelikof/GOA, Becharof NWR, Redoubt Bay CHA, Kachemak Bay SWP, AMNWR W Outer Kenai/GOA, AMNWR W Kodiak/Shelikof, AMNWR E Kodiak/GOA Afognak State Park
	≥6–<25	123, 126, 135, 138, 142, 153, 154, 156	Katmai NP, McNeil River SGR, Kenai AK State RMA, Clam Gulch CHA, AMNWR E Cook Inlet, Barren Islands, Shuyak Island State Park, AMNWR Afognak and Shuyak Islands, Kodiak National Wildlife Refuge Kachemak Bay CHA, Fox River Flats CHA, Kachemak Bay NERR	123, 126, 135, 138, 142, 153, 154, 156	Katmai NP, McNeil River SGR, Kenai AK State RMA, Clam Gulch CHA, AMNWR E Cook Inlet, Barren Islands, Shuyak Island State Park, AMNWR Afognak and Shuyak Islands, Kodiak National Wildlife Refuge Kachemak Bay CHA, Fox River Flats CHA, Kachemak Bay NERR
	≥25–<50	128	Lake Clark NP&P	--	--
	≥50	127	Alaska Maritime NWR	127, 128	Alaska Maritime NWR, Lake Clark NP&P

Notes: -- all percent chances of contact are <0.5.
[1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) is the same as 110 days in both seasons, but the individual results from each LA may not be identical.
Source: Appendix A (Tables A.1-15, A.2-30, A.2-35, A.2-50, and A.2-55). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

The OSRA model estimates Lake Clark National Park and Preserve on the western shore falls within the range of ≥25% to <50% of trajectories contacting from a VLOS during summer. Eleven Areas of Special Concern were identified within the range ≥6% to <25% (Table 4.12.18-1). Most of these Areas of Special Concern are located along the southwestern and eastern coastlines of Cook Inlet, but also include the shorelines of Kodiak NWR and Kodiak Island (Table 4.12.18-1; Appendix A, Table A.1-15). Nine Areas of Special Concern mostly aligned along the southeastern shoreline of the Alaska Peninsula have a percentage of trajectories contacting of ≥0.5% to <6%. The percent of trajectories contacting during winter from a VLOS is nearly identical to the summer scenario, with only minor differences for some

Areas of Special Concern. During the winter, GLS 128 within the Lake Clark National Park and Preserve results in an increase in the range of percent of trajectories contacting to ≥50%.

4.12.18.7. Conclusion

Severe impacts related to VLOS on Areas of Special Concern could be minimized by existing protections and use restrictions applicable to these areas. A VLOS could reach coastal areas of National Parks, NWRs, and National Forest sites. If these habitats were oiled, the impacts would be more persistent and require some level of remediation. Impacts could result from oiling of the shoreline and mechanical damage during the cleanup process. In the unlikely event of a VLOS, it has been assessed through the OSRA modeling effort that the Alaska Maritime NWR and Lake Clarke National Park and Preserve have a ≥50% of VLOS trajectories contacting during summer and winter. The impacts to these Areas of Special Concern would depend on the location and size of the spill, the type of product spilled, environmental conditions, and the type of area affected. If oil from a VLOS were to reach an Area of Special Concern, the area and the resources contained within it would be adversely affected. Impacts would be unavoidable and could persist for multiple years. Overall, a VLOS could result in **major** impacts to Areas of Special Concern.

4.12.19. Oil and Gas and Related Infrastructure

As discussed and summarized in Section 4.3.18, large accidental oil spills could result in minor impacts to the existing oil and gas and related infrastructure resource. Per Section A-7 of the Oil-spill Risk Analysis in Appendix A, the hypothetical VLOS scenario would involve a well control incident in which a subsea release in shallow to moderate depths would move through the water in three zones: a jet zone causing turbulence and droplet formation; a buoyancy zone where oil and gas are carried to the surface; and a surface interaction zone where the oil spreads and moves with surface currents. In particular, the oil associated with the surface interaction zone could have long lasting and widespread impacts on existing oil and gas infrastructure in Cook Inlet. The potential IPFs for each phase of the hypothetical VLOS are summarized in Table 4.12-1.

4.12.19.1. Phase 1 (Initial Event)

The initial event, which could last up to two days, is anticipated to have a short-term and localized impact to the existing oil and gas infrastructure. The loss of well control and blowout, together with a possible explosion and fire, would necessitate emergency actions aimed at life safety, potential search and rescue, and the early stages of incident assessment. These activities could have a minor impact on the existing oil and gas infrastructure, none of which is in the immediate vicinity of the proposed Lease Sale Area or in Federal waters.

4.12.19.2. Phase 2 (Offshore Spill)

Oil on the sea surface could cause impacts to existing oil and gas infrastructure. These impacts could be direct, as in surface oil impacting existing oil and gas operations and support operations in state waters, and indirect. An example of an indirect impact would be a regulatory action to temporarily suspend all offshore oil and gas development in Cook Inlet until the cause of the spill was determined, or the assurances that a similar spill could not occur with any of the existing offshore operations. Phase 2 impacts are considered to be long lasting (weeks to possibly several months) and widespread, and thus moderate.

4.12.19.3. Phase 3 (Onshore Contact)

Onshore contact of oil resulting from a VLOS would likely have widespread shoreline impacts throughout Cook Inlet. These shoreline impacts, or the threat of such impacts, could close ports and restrict the movements of vessels from port to port, or from port to offshore platform, or the reverse.

Potential impacts of this phase on oil and gas infrastructure are estimated to be moderate and last up to several months.

4.12.19.4. Phase 4 (Spill Response and Cleanup)

In the event of a VLOS, the USCG would most likely declare a maritime security zone over a wide area of Cook Inlet to allow cleanup operations to proceed as quickly as possible. The objectives of this action would be to reduce the chance of oiling maritime vessels and to limit further distribution of the oil through contact and movement of vessel hulls. Airspace closure in and around the slick area for all but essential air support for the spill cleanup could occur. Closures of sea lanes and airspace over all or part of Cook Inlet would likely have a moderate impact on offshore oil and gas infrastructure. Additional indirect impacts that would likely occur during this phase include the prioritization of all available logistics assets to support spill response efforts, limiting some of the support required for ongoing oil and gas development on land and in Cook Inlet. Potential impacts of this phase could be moderate and last up to several months.

4.12.19.5. Phase 5 (Post-Spill, Long-Term Recovery)

Phase 5 would likely have minor impact to oil and gas infrastructure. However, should regulations be developed during this phase that require the retrofitting or upgrading of existing oil and gas infrastructure, this could have a moderate impact that could be of long-term duration.

4.12.19.6. Oil-spill Risk Analysis

The OSRA model conditional probability results in Appendix A estimate that a percentage of trajectories from a VLOS could contact resources as far south as Shelikof Strait and east of Kodiak Island within 110 days during the VLOS release. Shoreline oiling in these areas will require characterization, cleanup where feasible, and ongoing monitoring.

4.12.19.7. Conclusion

During Phases 1 and 5, potential impacts to oil and gas infrastructure are likely to be short duration and localized, and thus minor, though Phase 5 could have moderate impacts if the regulatory response to a VLOS requires extensive modifications and updates to existing oil and gas infrastructure. Phases 2, 3, and 4 could cause long lasting and moderate impacts to the oil and gas infrastructure for several months. In considering the impacts associated with all five phases of a VLOS, the overall potential impact to the oil and gas infrastructure is estimated to be **moderate**.

4.12.20. Environmental Justice

The evaluation of environmental justice impacts of proposed Lease Sale 244 on minority populations and Indian tribes living in the proposed Lease Sale Area focuses on the Alaska Native, subsistence-based communities (see Section 4.3.20). For Lease Sale 244, environmental justice communities are Tyonek (Upper Cook Inlet); the central Kenai Peninsula (Ninilchik and the Kenaitze and Salamatof Indian populations); the lower Kenai Peninsula (Seldovia, Nanwalek, and Port Graham); Kodiak Island (Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions); and the southern Alaska Peninsula (Chignik Bay, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville). These are classified as environmental justice communities based on their disproportionally high Alaska Native populations (see Section 3.3.10).

Large oil spills and the associated spill response and cleanup activities could have disproportionately high and adverse effects on environmental justice communities in Cook Inlet. Cook Inlet provides habitats that are critical in the life cycle of many species of fish, birds, marine mammals, and marine invertebrates that are important to these communities for subsistence purposes. Degradation of these resources and their habitats from a VLOS could be severe for the subsistence harvest patterns exhibited by environmental justice communities in the proposed Lease Sale Area. Impacts from a VLOS would affect environmental justice communities to a greater extent and magnitude than for non-subsistence-based, predominantly non minority communities in the proposed Lease Sale Area. These environmental justice communities depend on wild food production and distribution more so than non-subsistence-based communities (see Table 3.3.4-2). Environmental justice communities also have lower development of wage and market sectors in their economies than the non-environmental justice communities in the proposed Lease Sale Area. Environmental justice communities are organized around extended kinship sharing patterns to a far greater extent than non-environmental justice communities. This makes environmental justice communities more vulnerable to sociocultural and economic impacts from a VLOS than non-environmental justice communities.

The potential impacts of a large oil spill on environmental justice communities are described in detail in Section 4.3.20. The potential impacts of a VLOS would be similar in nature but greater in magnitude and duration, owing to the volume and duration of the spill. Potential impacts of a VLOS are anticipated to be severe and thus major for subsistence harvest patterns and sociocultural systems in the proposed Lease Sale Area (see Sections 4.12.12 and 4.12.13, respectively).

Executive Order 12898 directs BOEM to only consider high and adverse (i.e., major) impacts to environmental justice communities. Accordingly, this analysis only discusses Phases 3, 4, and 5 of a VLOS.

4.12.20.1. Phase 3 (Onshore Contact)

Resources coming into contact with oil; contamination to environmental resources, habitat, and food sources; and loss of access to and use of affected areas are the relevant factors in this phase. Oiling of coastal habitats would be expected to cause severe displacement of species in the oiled areas and contribute to reduced reproductive success. The impact of onshore contact of a VLOS on environmental justice communities depends on weather patterns, spill size, spill location, and season, and will vary according to community. The overall impact of Phase 3 on environmental justice communities could be disproportionately high and adverse depending on the extent to which subsistence activities are disrupted.

4.12.20.2. Phase 4 (Spill Response and Cleanup)

The potential IPFs related to Phase 4 that would be relevant to environmental justice communities include the activities conducted by vessels and aircraft, *in situ* burning of oil, beach cleaning, and use of local and regional resources. A fleet of vessels and substantial amounts of in-water equipment will be required to contain, track, remove, and sample the oil spill environment. Depending on the extent of the spill and the response plan, the extent of spill response and cleanup efforts from these vessels could extend over an area of hundreds of square kilometers. The number of workers employed for cleanup would depend on the size of the spill and several other factors. Impacts to the environmental justice communities during this phase could be severe as spill response and cleanup activities may continue for years after the initial spill. Depending on the size of the spill and the extent to which it disrupts subsistence activities, impacts on environmental justice communities could be disproportionately high and adverse for Phase 4.

4.12.20.3. Phase 5 (Post-Spill, Long-Term Recovery)

The potential IPFs related to Phase 5 include lack of resources, contamination or the perception of contamination, and continued use of local and regional resources. Oil persistence in coastal and intertidal areas would be highly variable (from weeks to years) depending on substrate type and weather factors. Biodegradation and weathering of intertidal areas in cold waters have been shown to be on the order of months to decades (Prince, Owens, and Sergy, 2002). A recent study of biodegradation in the Arctic showed that as temperature increased in the Arctic summer, biodegradation increased (Chang, Whyte, and Ghoshal, 2011). Persistent oiling of coastal habitats would most likely cause food contamination, perceptions of food contamination, and disruptions to well-being for some coastal communities which could persist for extended periods. Impacts on environmental justice communities could be disproportionately high and adverse for Phase 5.

4.12.20.4. Oil-spill Risk Analysis

The OSRA model results in Appendix A estimate that some percent of trajectories from a VLOS could contact as far south as Shelikof Strait and east of Kodiak Island within 110 days of the initial release. This analysis identifies the LSs or GLSs that are proximal to or contain environmental justice communities (Appendix A, Tables A.1-16 to A.1-17). These tables provide estimates of the percentage of trajectories contacting a LS or GLS within 110 days during summer and winter for the Kenai Peninsula, and results are summarized in Table 4.12.20-1.

Table 4.12-4. VLOS Trajectories Contacting Selected EJ Communities on the Kenai Peninsula[1]

OSRA Feature Type	Highest Percentage of Trajectories	Summer	Winter
		110 days[2]	110 days
Land Segment (LS)	≥0.5–<6	55 (Ninilchik)	55 (Ninilchik), 61(Seldovia)
	≥6–<25	61 (Seldovia), 62 (Nanwalek, Port Graham)	62 (Nanwalek, Port Graham)
Grouped Land Segment (GLS)	≥6–<25	141	141

Notes: [1] Highest percentage of trajectories from any launch area (LA) during summer or winter. Note that only ERAs, LSs, and GLSs with percentages ≥0.5 are shown.
[2] Note that the highest percent chances of contact within 30 days (Section 4.3) is the same as 110 days in both seasons, but the individual results from each LA may not be identical.

Source: Appendix A (Tables A.1-11, A.2-25, A.2-30, A.2-35, A.2-45, A.2-50, and A.2-55). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a through A-4b.

While the potential impacts of a VLOS on environmental justice communities would be similar to the impacts discussed for accidental large spills in Section 4.3.20, the magnitude, extent, and duration of the potential impacts would differ, but would also be disproportionately high and adverse for environmental justice communities. Weathering is not built into the OSRA model simulation, but it is a factor that must be considered in impact analysis. Mass balance calculations presented in Appendix A, Table A.1-28, suggest the volume of oil that persists after 30 days is 24% (for a summer spill) and 3% (for a winter spill, unless ice is present).

LSs 61 and 62 on the tip of the Kenai Peninsula where Port Graham and Seldovia are located have ≥6% to <25% of trajectories contacting the resource during the summer. The ≥6% to <25% of trajectories contacting during winter would be limited to LS 62. LS 55 includes Ninilchik and has an estimated percent of VLOS trajectories contacting the resource between ≥0.5% to <6%.

4.12.20.5. Conclusion

The greatest potential for large-scale impacts to environmental justice communities would occur during Phase 3 of a VLOS when spilled oil makes landfall. Due to their location on or near the coastline most environmental justice communities would be expected to experience severely adverse impacts during this phase. Weathering of oil, which varies by season, would play a role in the volume of oil that could reach environmental justice communities. The degree and severity of adverse impacts to environmental justice communities would depend on the size of the event and its point of origin; the larger a spill, the greater the likelihood that environmental justice communities could be disproportionately impacted. Overall, impacts to environmental justice communities are anticipated to be disproportionately high and adverse for a VLOS event because subsistence harvest practices and availability of subsistence resources would be severely disrupted compared to non- environmental justice communities in the proposed Lease Sale Area.

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.

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.