Alaska Outer Continental Shelf

OCS EIS/EA
BOEM 2020-063

Cook Inlet Planning Area

Oil and Gas Lease Sale 258
In Cook Inlet, Alaska

Draft Environmental Impact Statement

VOLUME 1: Chapters 1-5
Appendix A

Prepared by
Bureau of Ocean Energy Management
Alaska OCS Region

Estimated Lead Agency
Total Costs Associated with
Developing and Producing this EIS:
$548,000.00

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

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List of Acronyms and Abbreviations

2D	two dimensional
3D	three dimensional
AAAQS	Alaska Ambient Air Quality Standards
ac	acres
ADF&G	Alaska Department of Fish and Game
ANCSA	Alaska Native Claims Settlement Act
APDES	Alaska Pollutant Discharge Elimination System
AQCR	Cook Inlet Intrastate Air Quality Control Region
ASAP	Alaska Stand-Alone Natural Gas Pipeline
AWQS	Alaska Water Quality Standards
bbl	barrels
Bbbl	billion barrels
Bcf	billion cubic feet
BLM	Bureau of Land Management
BOE	barrels of oil equivalent
BOEM	Bureau of Ocean Energy Management
B.P.	before present
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
$CaCO_3$	calcium carbonate
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	methane
CINGSA	Cook Inlet Natural Gas Storage Area
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CSIS	Community Subsistence Information System
CWA	Clean Water Act
cy	cubic yards
dB_{RMS}	Decibels Root Mean Square
DPP	Development and Production Plan
DPS	distinct population segment
E&D	Exploration and Development
EDPS	Eastern Distinct Population Segment
EFH	essential fish habitat
EIA	U.S. Energy Information Administration
EIS	environmental impact statement
EJ	Environmental Justice
EO	Executive Order
EP	Exploration Plan
EPA	U.S. Environmental Protection Agency
ERA	environmental resource area
ESA	Endangered Species Act
EVOS	*Exxon Valdez* Oil Spill
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement

ft	foot/feet
FR	Federal Register
G&G	geological and geophysical
GDP	Gross Domestic Product
GHG	greenhouse gases
GIUE	Government Initiated Unannounced Exercise
GLS	grouped land segment
GOA	Gulf of Alaska
ha	hectares
Hg	mercury
Hilcorp	Hilcorp Alaska, LLC
Hz	hertz
IBA	Important Bird and Biodiversity Area
IRA	Indian Reorganization Act
ITL	Information to Lessees and Operators
IWG	Interagency Working Group on the Social Cost of Greenhouse Gases
JBER	Joint Base Elmendorf-Richardson
km	kilometers
KPB	Kenai Peninsula Borough
LNG	liquefied natural gas
LS	lease sale or land segment
LS 258	Lease Sale 258
m	meters
Mat-Su	Matanuska-Susitna
Mbbl	thousand barrels
MGS	Middle Ground Shoal
mi	miles
MMbbl	million barrels
MODU	mobile offshore drilling unit
mmBOE	millions of barrels of oil equivalent
MMPA	Marine Mammal Protection Act
N/A	not applicable
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEMS	National Energy Modeling System
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
nmi	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_2/NOx	nitrogen dioxide / oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
NPP	National Park and Preserve
NTL	Notice to Lessees and Operators
O^3	ozone
OCD	Offshore and Coastal Dispersion Model
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act of 1953

OECM	Offshore Environmental Cost Model
OSRA	oil spill risk analysis
Pb	lead
$PM_{2.5}$	particulate matter equal to or less than 2.5 micrometers
PM_{10}	particulate matter equal to or less than 10 micrometers
ppm	parts per million
PSD	Prevention of Significant Deterioration
PSO	protected species observer(s)
RFFA	reasonably foreseeable future action
ROD	Record of Decision
RSLP	Regional Supervisor, Leasing and Plans
SHPO	State Historic Preservation Office
SO	Secretarial Order
SO_2	sulfur dioxide
SOA	State of Alaska
SOx	oxides of sulfur / sulfur oxides
SSB	State Seaward Boundary
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service
VLOS	very large oil spill
VOC	volatile organic compound(s)
WDPS	Western Distinct Population Segment

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CHAPTER 1: PURPOSE AND NEED FOR THE 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 on the Alaska Outer Continental Shelf (OCS) in the northern portion of the Cook Inlet Planning Area (Proposed Lease Sale Area). The entire planning area encompasses approximately 2.1 million hectares (ha) (~5.3 million acres (ac)) (Figure 1-1). The Proposed Lease Sale Area includes 224 OCS blocks that encompass approximately 442,537 ha (1.09 million ac).

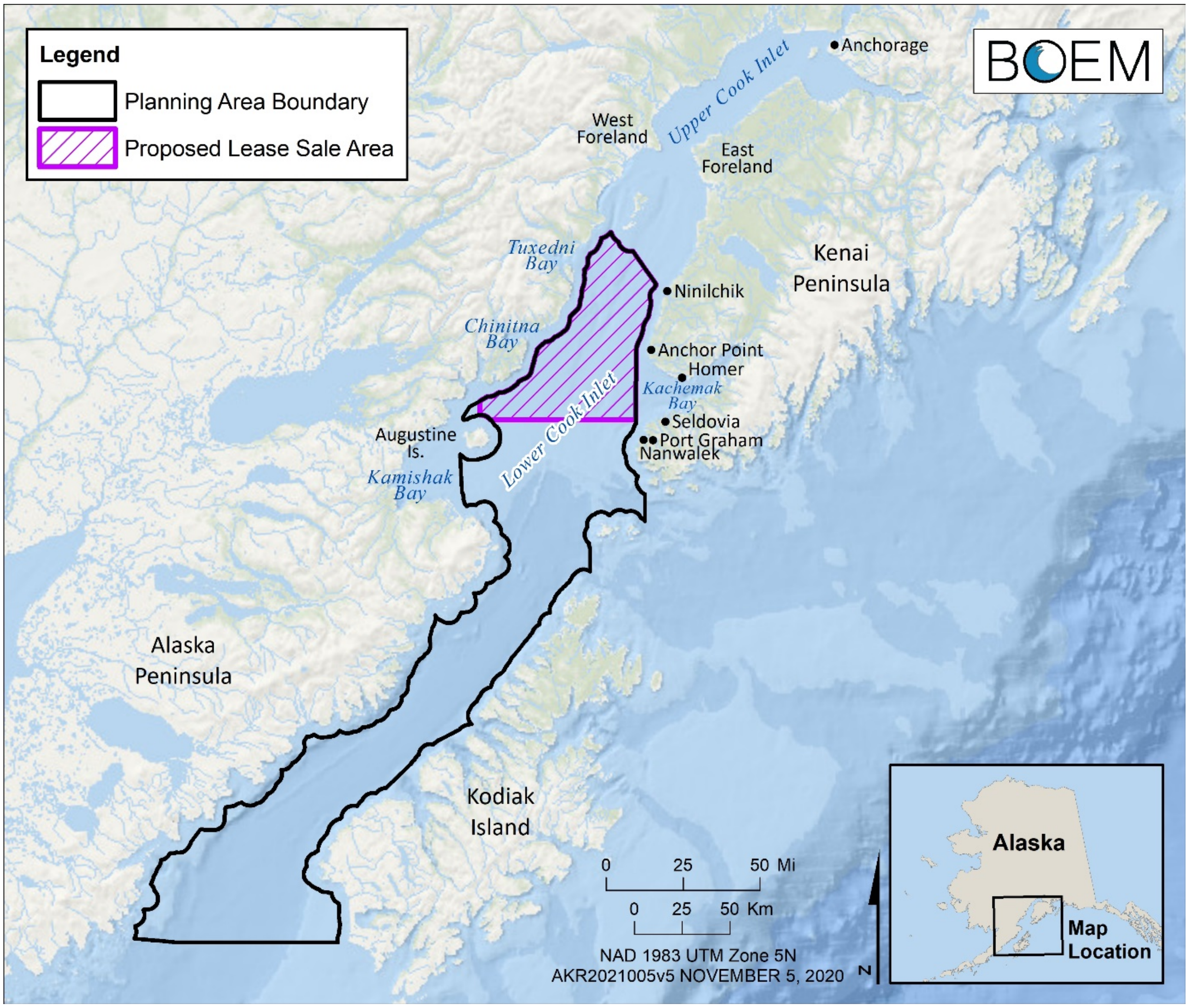


Figure 1-1: Cook Inlet Planning Area, Southcentral Alaska

The purpose of the Proposed Action addressed in this 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 (USC) 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.

Federal jurisdiction over energy and mineral development on submerged lands seaward of state boundaries was established by OCSLA. Under 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 (Secretary) is charged with developing the National 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. OCSLA grants the Secretary the authority to issue leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate regulations as necessary to carry out the provisions of the statute.

OCSLA sets forth a four-stage process for managing oil and gas resources on the OCS including planning (National Program), leasing (Lease Sale), exploration (Exploration Plan), and production (Development and Production Plan). On January 17, 2017 the Secretary decided to proceed with the 2017–2022 National OCS Oil and Gas Leasing Proposed Final Program (Proposed Final Program). The Proposed Final Program includes the proposed 2021 Cook Inlet Lease Sale. Operators who obtain lease rights on the OCS are then required to submit an Exploration Plan (EP) prior to exploration activities, and a Development and Production Plan (DPP) prior to development of production infrastructure. BOEM conducts separate, project-specific National Environmental Policy Act (NEPA) analyses prior to approving any EP or DPP.

The Call for Information and Nominations for proposed Cook Inlet Lease Sale 258 (LS 258) was published in the Federal Register (FR) (85 FR 55859, September 10, 2020) concurrently with a Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) (85 FR 55861)[1]. Publication of the NOI opened a scoping period that extended through October 13, 2020. BOEM disseminated information about the proposed lease sale using virtual methods (website, virtual meetings, and social media). Opportunity for public input was provided throughout the scoping period via a BOEM Virtual Meeting Room (https://www.boem.gov/ak258-scoping), four live virtual meetings (held September 29, October 1, and two on October 8, 2020), and https://www.regulations.gov.

As part of scoping, BOEM also conducted early coordination with appropriate federal and state agencies and other concerned parties to discuss and coordinate the pre-lease process for this lease sale and EIS. BOEM implements tribal consultation policies through formal government-to-government consultation, informal dialogue, collaboration, and engagement. BOEM also offered government-to-Alaska Native Claims Settlement Act (ANCSA) corporation consultation opportunities. BOEM is committed to maintaining open and transparent communications with Tribal governments, ANCSA corporations, Alaska Native organizations, and other indigenous communities. A more complete discussion of consultations and agency coordination is found in Chapter 5.

BOEM considered all comments received during scoping in the preparation of this EIS. The primary issues and concerns expressed included the impacts of post-lease activities to species (beluga whales, northern sea otters, Steller's eider) listed under the Endangered Species Act (ESA), ESA-designated critical habitat areas, and other protected areas; impacts to subsistence hunting, fishing, and food security; impacts to commercial and sport fishing; noise pollution associated with oil and gas related activities (including seismic impacts on fish and marine mammals), impacts to area resources and communities from an accidental oil spill; and the contribution to climate change. A scoping report summarizing the comments received on the NOI and at the public scoping meetings is posted on the BOEM website at https://www.boem.gov/ak258/.

1 BOEM has prepared this EIS under NEPA (1970) (P.L. 91–190, 42 U.S.C. 4321 *et seq.*), and Council on Environmental Quality (CEQ) regulations at 40 CFR Parts 1500–1508 (1978, as amended in 1986 and 2005). This EIS does not apply updated CEQ regulations published in the Federal Register Notice of Final Rule (85 FR 15179) on July 16, 2020, effective September 14, 2020.

CHAPTER 2: ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the Proposed Action and the alternatives analyzed in detail. It also describes alternatives identified but eliminated from detailed study and summarizes the reasons for their elimination. In addition to the Proposed Action and the No Action Alternative required by Council on Environmental Quality (CEQ) regulations, BOEM developed three alternatives based on public and agency input received during the scoping process and on alternatives previously analyzed for Lease Sale 244 (held in 2017). The chapter concludes with a comparison of alternatives.

The USDOI's 2012–2017 OCS Oil and Gas Leasing Program introduced a targeted leasing model to the Alaska OCS lease sale process and continued the model in the 2017–2022 National Program. 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 goal of targeted leasing is to focus oil and gas leasing on the most promising OCS blocks, while protecting important habitats and critical subsistence activities. The result is an area that is more geographically limited in scope and that eliminates many areas of environmental concern. BOEM used this information to develop the Area Identification (Area ID) for this lease sale. The Area ID was published in the Federal Register on January 15, 2021 (85 FR 4116). The Area ID 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 oil and gas activities;
- focuses on areas closer to active OCS and State of Alaska (SOA) oil and gas leases;
- avoids the vast majority of the ESA-designated critical habitat for the beluga whale and northern sea otter;
- completely avoids 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 first identified during the Lease Sale 191 (held in 2004) process.

Because many of the areas of environmental concern have already been removed or addressed through targeted leasing, BOEM has developed alternatives for this EIS that are targeted at a very specific set of important resources in Cook Inlet. Consequently, the alternatives analysis is structured to clearly highlight the purposes and differences between alternatives. The EIS is not a decision document but is among the pieces of information used by the decision maker on whether to hold the lease sale and under what terms and conditions. The decision maker may choose any of the following alternatives, or combine individual alternatives or pieces of the alternatives, in making its decision.

Alternatives subject to detailed analysis are described below. Although the alternatives are analyzed separately in the EIS, the decision could incorporate elements of multiple alternatives.

2.1 Alternative 1 – Proposed Action

The Proposed Action would offer for lease all available OCS blocks in the northern portion of the Cook Inlet Planning Area (Figure 2-1). The Proposed Lease Sale Area covers approximately 442,537 ha (1.09 million ac), representing approximately 20 percent of the total Cook Inlet Planning Area, 224 OCS blocks (85 FR 55861, September 10, 2020).

Figure 2-1: Proposed Cook Inlet Lease Sale 258 Area

2.2 Alternative 2 – No Action

Alternative 2 is the "No Action" alternative and is equivalent to cancellation of the Proposed Action (Figure 2-2). Under this alternative, Lease Sale 258 would not occur. The opportunity for development of potential oil and gas resources under the Proposed Action, along with its environmental impacts and benefits, would be precluded at this time or postponed to a future lease sale decision under a new National Program.

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 potential impacts to the Cook Inlet Distinct Population Segment (DPS) of the beluga whale. Public input during scoping for both Lease Sale 258 and the previously held Lease Sale 244 indicated concern for the beluga whale. The following alternatives were identified for detailed evaluation:

Alternative 3A – Beluga Whale Critical Habitat Exclusion. Under this alternative, the 10 OCS blocks that overlap with beluga whale critical habitat at the northern tip of the Proposed Lease Sale Area would be excluded from the lease sale (Figure 2-2). The areal extent of the affected OCS blocks is 7,085 ha (17,507 ac) or 1.60 percent of the Proposed Lease Sale Area. Beluga whale critical habitat within the excluded OCS blocks represents approximately 0.85 percent of the total area of the beluga whale critical habitat.

Alternative 3B – Beluga Whale Critical Habitat Mitigation. Under this alternative, all available blocks in the Proposed Lease Sale Area would be offered for lease. The 10 OCS blocks that overlap beluga whale critical habitat at the northern tip of the Proposed Lease Sale Area would be included in the lease sale; however, no on-lease seismic surveys or exploration drilling would be conducted between November 1 and April 1 when beluga whales are most likely to be present.

Alternative 3C – Beluga Whale Nearshore Feeding Areas Mitigation. Under this alternative, all available blocks would be offered for lease with seasonal mitigation to protect beluga whales. Certain seasonal mitigations would be applied to all OCS blocks between November 1 and April 1. Additional seasonal mitigation would be applied to the 146 OCS blocks located wholly or partially within 10 miles (mi) of major anadromous streams. The following mitigations would be applied:

- On all blocks offered for lease, no on-lease seismic surveys would 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; and,
- On blocks within 10 mi of major anadromous streams, no on-lease seismic surveys would be conducted between July 1 and September 30 (when beluga whales are migrating to and from their summer feeding areas) (Figure 2-2).

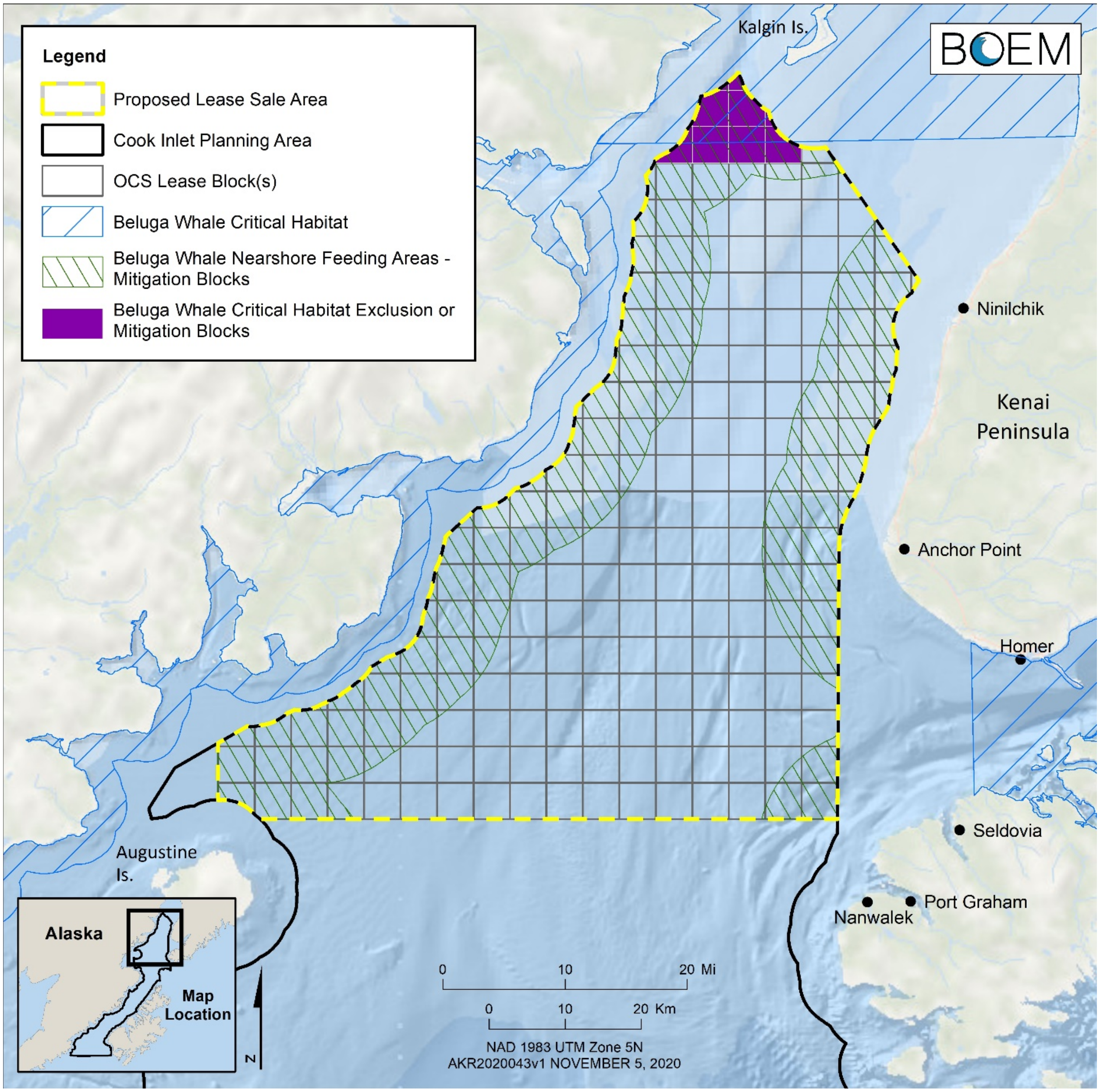


Figure 2-2: Beluga Whale Alternatives 3A, 3B, and 3C

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

Alternatives 4A and 4B were developed to address potential impacts to the Southwest Alaska DPS of the northern sea otter. Scoping for Lease Sale 258 and Lease Sale 244 indicated a concern for the northern sea otter. The following alternatives were identified for detailed evaluations:

Alternative 4A – Northern Sea Otter Critical Habitat Exclusion. Under this alternative, the 7 OCS blocks that overlap with northern sea otter SW DPS critical habitat would be excluded from the lease sale (Figure 2-3). The areal extent of the sea otter critical habitat within the Proposed Lease Sale Area is 3,300 ha (8,154 ac) or 0.75 percent of the Proposed Lease Sale Area.

Alternative 4B – Northern Sea Otter Critical Habitat Mitigation. Under this alternative, all available OCS blocks would be offered for lease with additional mitigation on the 14 OCS blocks located within 1,000 meters (m) of northern sea otter critical habitat. On these 14 OCS blocks the discharge of drilling fluids and cuttings and seafloor-disturbing activities (including anchoring and placement of bottom-founded structures) would be prohibited.

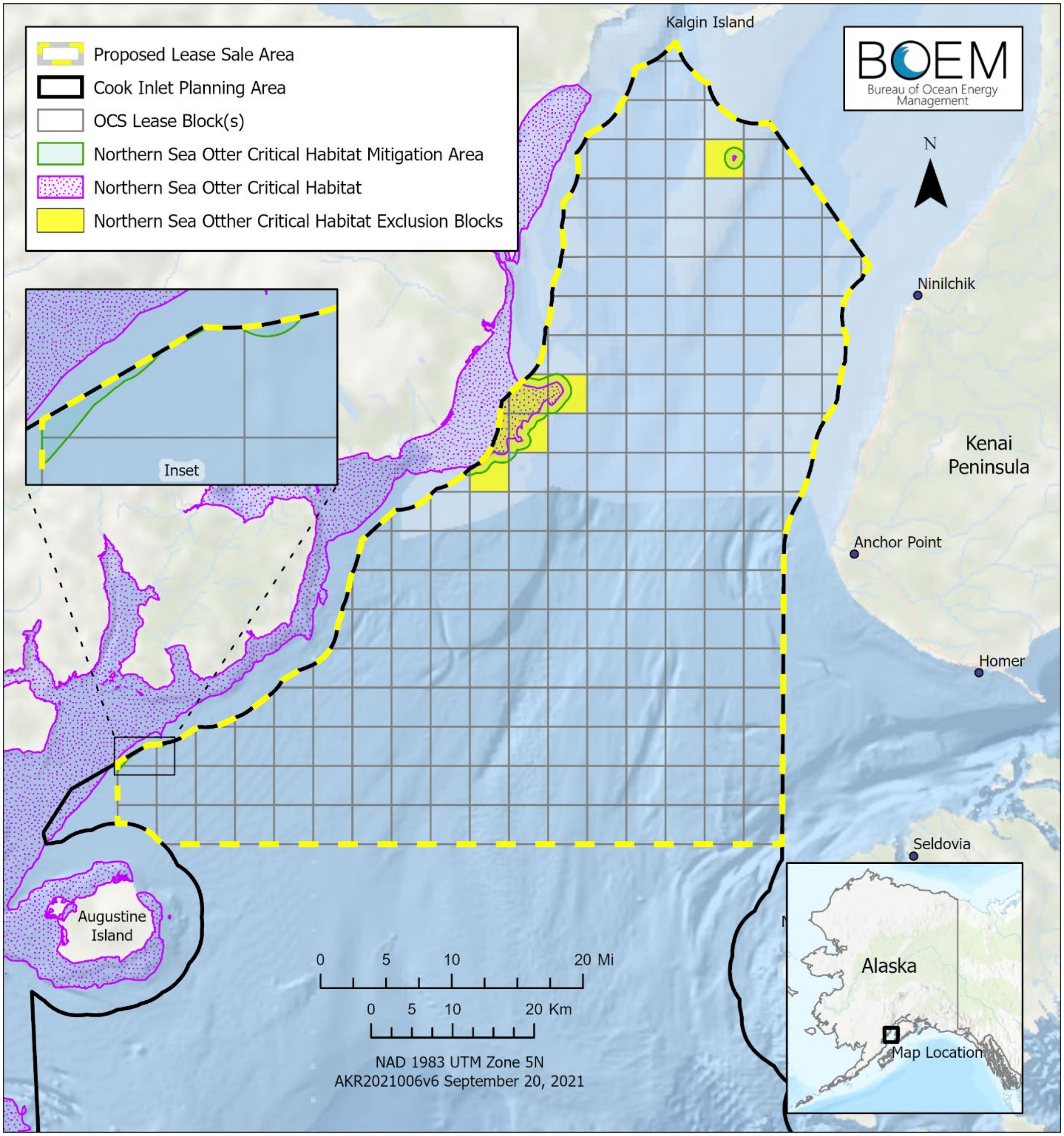


Figure 2-3: Northern Sea Otter Alternatives 4A and 4B

2.5 Alternative 5 – Gillnet Fishery Mitigation

Under Alternative 5, all available OCS blocks in the Proposed Lease Sale Area 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 203,779 ha (503,550 ac) or 46.0 percent of the Proposed Lease Sale Area (Figure 2-4). The following mitigation measures would be applied to the 117 whole or partial OCS blocks:

- No on-lease seismic surveys would be conducted during the drift gillnetting season as designated by the Alaska Department of Fish and Game (ADF&G) (approximately mid-June to mid-August).
- United Cook Inlet Drift Association must be notified of any temporary or permanent structures planned during the drift gillnetting season.

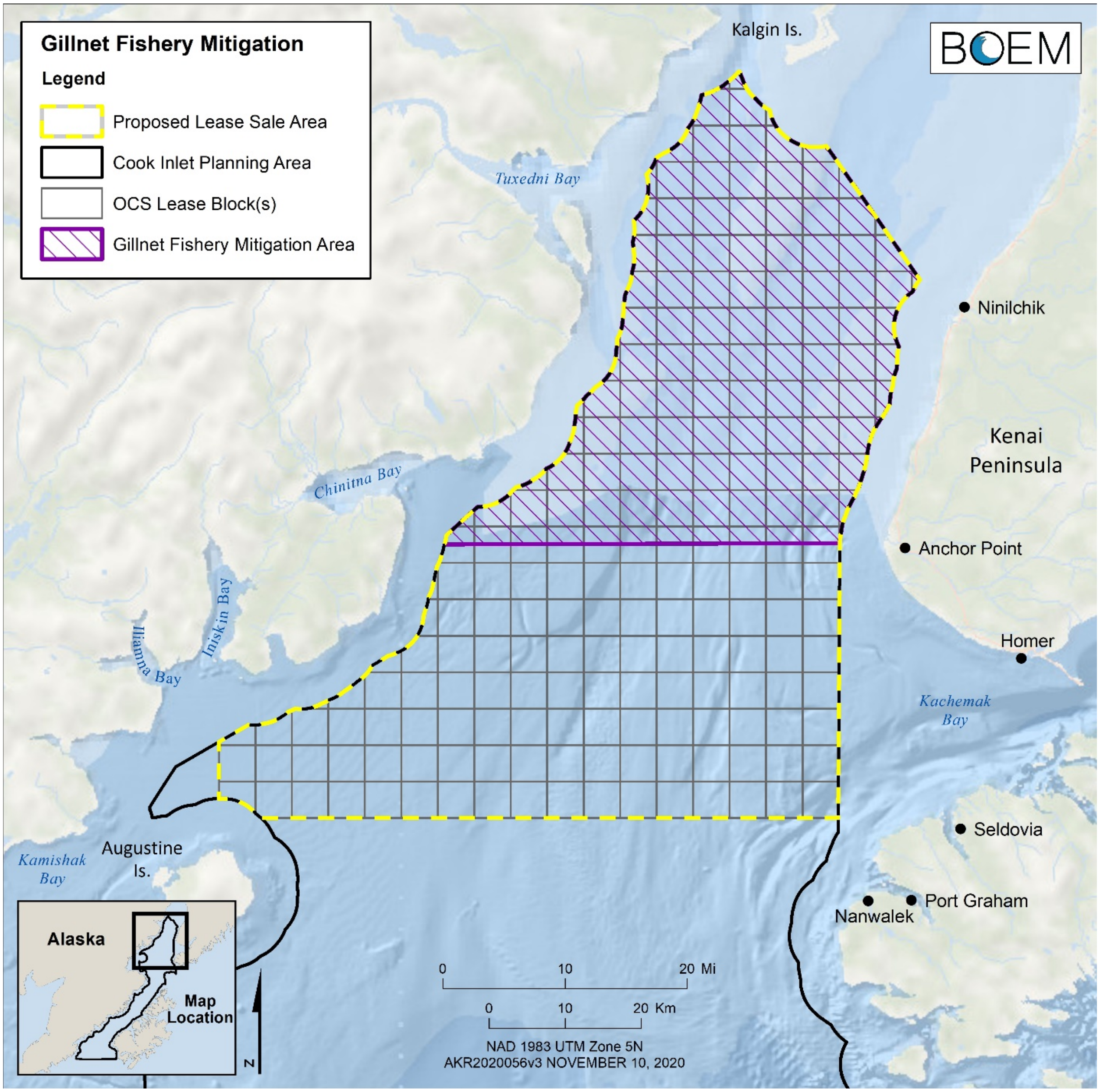


Figure 2-4: Gillnet Fishery Mitigation Alternative 5

2.6 Alternatives Considered but Dismissed from Detailed Analysis

The following alternatives were considered by BOEM but were eliminated from detailed analysis in the EIS.

2.6.1 Prohibition of Drilling Discharges

BOEM considered developing an alternative that would prohibit the marine discharge of all exploration drilling fluids and cuttings produced from post-lease activities resulting from LS 258. This alternative was analyzed in detail in the LS 244 EIS, where it was determined that the minimal decrease in environmental effects associated with the alternative was offset by an increase in impacts associated with barging muds and cuttings to shore. Consequently, this alternative was not selected in the LS 244 Record of Decision (ROD). Furthermore, the Environmental Protection Agency (EPA) regulates discharges of muds and cuttings through the National Pollutant Discharge Elimination System (NPDES) program and allows such discharges only if they would not cause unreasonable degradation of the marine environment. During scoping for this EIS, BOEM did not receive any requests or comments asking that it reconsider the prohibition of exploration drilling discharge. BOEM has determined, based on its past analysis, EPA's existing authority to regulate discharge through its NPDES program, and the response to scoping for this EIS, that the inclusion of this alternative for detailed analysis for the LS 258 EIS is not warranted.

2.6.2 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 kilometers (km) (2.5 mi) offshore (ADNR, 2015). BlueCrest Energy has proposed using 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 et al., 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 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 could be very high risk in 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 percent 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 percent of the Proposed Lease Sale Area would not be accessible. In addition, some OCS blocks within this range might require an onshore drill site be located in an inaccessible or protected area such as Lake Clark NPP.

2.6.3 Migrating Salmon Seismic Timing

An alternative that would prohibit any seismic surveys when migrating salmon are present was suggested during scoping. 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. Salmon are present in Cook Inlet year-round, and migrations can occur from May–November, with peak abundances from June–August. These migrating aggregations occur nearshore and in freshwater streams, outside of the Lease Sale Area. Although salmon migrate throughout Cook Inlet, large aggregations occur closer to streams. As a prey species for belugas, the protections for beluga feeding migrations (the Nearshore alternative) would also extend to migrating salmon when they are present in high abundances. BOEM therefore determined that the suggested alternative was duplicative of existing alternatives and the alternative was not analyzed in detail. Additionally, the Gillnet Fishery alternative would prohibit seismic activity in the northernmost 117 OCS blocks during the drift gillnet season, as designated by the ADF&G, which substantially overlaps with salmon migration season.

2.6.4 North Pacific Right Whale and North Pacific Right Whale Critical Habitat

An alternative that would prohibit any exploration or drilling activities from June to September when the waters outside Cook Inlet in the Gulf of Alaska are designated as biologically important areas for North Pacific right whales was suggested during scoping. As a result of targeted leasing, North Pacific right whales and designated North Pacific right whale critical habitat are outside the Proposed Lease Sale Area and not likely to be impacted by post-lease activities as a result of the proposed lease sale. BOEM therefore determined that additional exploration activity restrictions based on considerations for North Pacific right whales were not warranted and the alternative was not analyzed in detail.

2.6.5 Northern Area Exclusion

BOEM also considered alternatives that were previously considered within the NEPA process associated with Lease Sale 244. This alternative would exclude all whole or partial OCS blocks north of Anchor Point as recommended by the Marine Mammal Commission and other scoping commenters. This alternative would remove 117 OCS whole or partial blocks and reduce the Proposed Lease Sale Area by 203,779 ha (503,550 ac), or 46.0 percent. 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, 2008a; Ferguson et al., 2015).

BOEM determined that this alternative would not meet the purpose and need of Lease Sale 258 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 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 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).

2.6.6 Lower Kenai Peninsula Exclusion

Alternatives previously associated with Lease Sale 191 were also considered. 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 (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 of 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 were already excluded from the Proposed Action. Only 9 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 4.11. 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 3.3. 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. 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 Peninsula exclusion alternative was not evaluated in detail.

2.7 Comparison of Alternatives

The results of the impact analysis for the Proposed Action are summarized in Table 2-1. 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 (Section 4.2). Table 2-1 shows ratings for post-lease activities, as described in the Exploration and Development Scenario (E&D Scenario) (Section 4.1), including probable small spills as described in the Oil Spills and Gas Release Scenario (Section 3.1.1); as well as a separate rating reflecting the addition of a large spill, also described in the Oil Spills and Gas Release Scenario (Section 3.1.2).

Table 2-1: Summary of Potential Impacts of Alternative 1 (Proposed Action)

Resource	Impacts of Alternative 1 (Proposed Action)	Post-Lease Activities[1]	Large Spill[2]
Air quality	Impacts from emissions during surveys, exploration, and production operations.	Minor[3]	Minor to Moderate
Water quality	Increase in TSS from construction activities; discharge of exploration and delineation well rock cuttings and fluids, and other operational discharges; petroleum hydrocarbon contamination could persist in sediments or ice and be reintroduced into the water column.	Minor	Moderate
Coastal and estuarine habitats	Impacts from seafloor-disturbance activities, discharges, pipeline landfalls, and onshore construction.	Minor	Major
Fish and invertebrates	Impacts from noise, habitat alteration and disturbance due to platforms and vessels.	Minor	Moderate
Birds	Vessel operations or marine habitat alterations could displace birds or interfere with foraging, and some waterbird populations could experience impacts lasting beyond a single season. Bright artificial lighting or gas flaring from vessels and platforms could cause collisions of migrating birds.	Minor to Moderate	Minor to Major
Marine mammals	Impacts could result from noise associated with seismic airguns and pile-driving; habitat alteration; and vessel strikes.	Negligible to Minor	Minor to Moderate
Terrestrial mammals	Most impacts would be localized to the site of the project infrastructure offshore, geographically distant from terrestrial habitats.	Minor	Minor
Recreation, tourism, and sport fishing	Impacts would primarily arise from disturbance in the form of space-use conflicts. Access to some sport fishing areas may be temporarily limited and some short-term displacement of populations of sport species such as salmon and halibut may result.	Minor	Moderate
Communities and subsistence	Short-term and localized impacts would include changes in availability of subsistence resources and space-use conflicts.	Minor	Major
Economy	Economic impacts related to employment, wages, and revenues would be closely tied to the size of a resource discovery – the larger the discovery the greater the impact.	Negligible to Moderate	Minor
Commercial fishing	Impacts could include displacement of targeted fish species and localized disturbance of fishing activities. For some fisheries, such as salmon gillnetting, impacts could be moderate due to space-use conflicts.	Minor to Moderate	Major
Archaeological and historic resources	Impacts include potential damage or destruction of resources from seafloor and ground disturbance, or offshore discharges.	Negligible to Minor	Moderate
Environmental justice	No major impacts for subsistence activities and harvest patterns, air quality, water quality, or the biological resources harvested for subsistence.	No Disproportionate Effects	Disproportionate Effects

Notes: TSS = total suspended solids
1 Post Lease Sale 258 activities described in the E&D Scenario (Section 4.1) and small spills (Section 3.1.1).
2 Large spill described in Section 3.1.2.
3 Impact Scale described in Section 4.2.

Table 2-2 compares the impacts of the No Action Alternative and Alternatives 3 through 5 relative to the Proposed Action. The overall impact ratings (i.e., negligible, minor, moderate, major) did not differ among action alternatives for any resource, with the exception of commercial fishing. Specific differences in impacts were identified for each resource in Chapter 4, Sections 4.3 through 4.14 and are summarized here.

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

Alternative	Positive Impacts	Negative Impacts
2 – No Action	• Avoids all negative environmental impacts of the Proposed Action.	• Environmental impacts may occur from the likely substitutes for the lost oil and gas production, though not necessarily in the Proposed Lease Sale Area. • Economic benefits from the Proposed Action would be precluded or delayed.
3A – Beluga Whale Critical Habitat Exclusion	• Avoids most impacts on beluga whales and beluga whale critical habitat in 10 OCS blocks. • May slightly reduce interactions with drift gillnet fishers at northern edge of Proposed Lease Sale Area (exclusion would eliminate 8.5% of the blocks north of Anchor Point). • Reduction in impacts from seismic sounds would benefit anadromous fish, including salmon species and commercial salmon fisheries. Impact level for commercial fishing would be slightly reduced from minor-to-moderate to minor. • Eliminates impacts to birds while they are present in the exclusion area.	• The 10 OCS blocks that overlap with beluga whale critical habitat would be excluded from the lease sale. The areal extent of the affected OCS blocks is 7,085 ha (17,507 ac) or 1.60% of the Proposed Lease Sale Area. • Potential for resource development would be lost on 10 OCS blocks along with associated economic benefits.
3B – Beluga Whale Critical Habitat Mitigation	• Reduces impacts on beluga whales and beluga whale critical habitat in 10 OCS blocks. • Eliminates impacts from on-lease seismic surveys and exploration drilling between November 1 and April 1 when beluga whales are most likely to be present. • Reduction in impacts from seismic sounds would benefit anadromous fish, including salmon species and commercial salmon fisheries. Impact level for commercial fishing would be slightly reduced from minor-to-moderate to minor. • A few impacts would be eliminated for wintering birds.	• The 10 OCS blocks that overlap with beluga whale critical habitat would restrict on-lease seismic surveys or exploration drilling between November 1 and April 1 potentially having negative economic impacts to lessees.

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

Alternative	Positive Impacts	Negative Impacts
3C – Beluga Whale Nearshore Feeding Areas Mitigation	• Reduces impacts from on-lease marine seismic surveys on all blocks between Nov. 1 and April 1 when beluga whales are most likely to be present and distributed across lower Cook Inlet. • Reduces impacts on beluga whale nearshore feeding areas in 146 OCS blocks located wholly or partially within 10 miles of major anadromous streams. • Eliminates or reduces impacts of noise between July 1 to September 30 when beluga whales are migrating to and from their summer feeding areas. • Reduction in impacts from seismic sounds would benefit anadromous fish, including salmon species and commercial salmon fisheries. Impact level for commercial fishing would be slightly reduced from minor-to-moderate to minor. • Provides some additional protections from underwater noise, vessel disturbance, and collision risk for some wintering marine birds.	• No on-lease seismic surveys would be permitted between November 1 and April 1 on all 224 OCS blocks. Additionally, for the 146 OCS blocks OCS blocks located wholly or partially within 10 miles of major anadromous streams, lessees would be prohibited from conducting on-lease seismic surveys between July 1 and September 30. • These restrictions could result in a negative economic impact to lessees.
4A – Northern Sea Otter Critical Habitat Exclusion	• Avoids most impacts on sea otters and sea otter critical habitat in 7 OCS blocks. • Would eliminate impacts for marine birds while they are foraging in the 7 OCS blocks.	• The 7 OCS blocks that overlap with northern sea otter crucial habitat would be excluded from the lease sale. The areal extent of the sea otter critical habitat within the Proposed Lease Sale Area is 3,300 ha (8,154 ac) or 0.75%. • Potential for resource development and associated economic benefits would be lost on these 7 OCS blocks.
4B – Northern Sea Otter Critical Habitat Mitigation	• Reduces impacts on sea otters and sea otter critical habitat in 14 OCS blocks located within 1,000 m of sea otter critical habitat. • Would benefit benthic habitat and reduce impacts to benthic-foraging birds.	• On the 14 OCS blocks located within 1,000 meters of northern sea otter critical habitat, discharge of drilling fluids and cuttings and seafloor-disturbing activities (including anchoring and placement of bottom-founded structures) would be prohibited. • These restrictions could result in a negative economic impact to lessees.
5 – Gillnet Fishery Mitigation	• Reduces risk of interactions with drift gillnet fishers by prohibiting on-lease seismic surveys on 117 whole or partial OCS blocks during the drift gillnet season and by requiring notification of and coordination with gillnet fishers. • Reduces impacts on beluga whales during important summer feeding and rearing times. • Decrease in impacts to commercial drift gillnet fishery because no space-use conflicts or impacts to the targeted fishery would occur from seismic surveys. Overall Impact level for commercial fishing would be slightly reduced to minor.	• No on-lease seismic surveys would be permitted during the drift gillnetting season as designate by the ADF&G (approximately mid-June to mid-August on the 117 whole or partial OCS blocks north of Anchor Point. This alternative would affect an area of 203,779 ha (503,550 ac) or 46.0% of the Proposed Lease Sale Area. • This alternative could result in a negative economic impact on lessees.

CHAPTER 3: ASSUMPTIONS FOR ANALYSIS

This chapter describes the assumptions upon which BOEM analysts based their effects analyses. To give the decision maker and reader an idea of the types of activities that could follow leasing, and to provide BOEM analysts with a reasonable and consistent basis for their effects analyses, BOEM develops hypothetical scenarios. This chapter begins by describing the Oil Spills and Gas Release Scenario and then provides the past, present, and reasonably foreseeable future activities that informed BOEM's cumulative effects analyses. The assumptions described below, with the addition of the E&D Scenario described in Chapter 4, provide the basis for analysis for each action alternative. This chapter also summarizes the regulatory and administrative framework in which post-lease activities would occur; describes the lease stipulations considered for inclusion on all issued leases; and identifies assumed and proposed mitigation measures considered in the analyses.

3.1 Oil Spills and Gas Release Scenario

During scoping the public expressed concern about the potential for spills or release of hydrocarbons into the environment as a result of LS 258. Oil spills and gas releases are illegal, accidental events. With the exception of rare events like the Deepwater Horizon oil spill, both the number of spills and the volume of oil entering the environment from accidental spills have decreased in recent decades, even as petroleum consumption has risen or remained flat (ABS Consulting, 2016; USCG, 2012; USEIA, 2020).

The effects of oil spills and a gas release that could result from the high activity estimate provided in the E&D Scenario (production of 192.3 MMbbl of oil and 301.9 Bcf of gas) are analyzed in Appendix A, Section A-3. The spill and gas release assumptions were developed using technical information and historic data as well as the assumptions in the hypothetical E&D Scenario, modeling results, statistical analysis, and professional judgment (detailed in Appendix A, Section A-2). The analyses are based on a set of assumptions about the number, volume, and types of spills estimated to occur.

3.1.1 Small Oil Spills: <1,000 bbl

Over the past 50 years small spills on the OCS have occurred with generally routine frequency and are considered probable given the activities associated with the Proposed Action and described in the E&D Scenario. The majority of small spills would be contained. Refined spills reaching the environment would evaporate and disperse within hours to a few days, but small crude spills take longer.

Assumptions for analysis of small oil spill effects are described in Table 3-1. Approximately 410 small spills are estimated to occur over the 40-year E&D Scenario.

Table 3-1: Small Spill Scenario Assumptions

Variable	Assumption for Purposes of Analysis
Number	Approximately 410 total – Rounded to nearest 10.
Activities	Small, refined oil spills occur during G&G activities, exploration and delineation drilling activities, development and production, and decommissioning activities. Small crude and condensate oil spills occur during development and production activities.
Timing	Small, refined oil spills during G&G or exploration and delineation activities could occur any time of the year. Small refined and crude oil spills during development and production could occur any time of the year.
Size	G&G Activities: most would be <1 bbl; one would be up to13 bbl. Exploration and Delineation drilling: most would be 0 up to 5 bbl; one would be up to 50 bbl. Development and Production: most would be <1 bbl, 14 would be 3 bbl, and 2 would be 125 bbl each and assumed to occur from either offshore or onshore facilities.
Media Affected	Vessel or facility and then the water or ice; open water; broken ice; on top of or under solid ice; shoreline; or snow.
Weathering	50 bbl diesel spill evaporates and disperses within 3 days. Diesel spills of <1 bbl evaporate and disperse within 6–24 hours. 125 bbl crude spill evaporates and disperses over 30 days.

Notes: bbl = barrel G&G = geological and geophysical

3.1.1.1 Exploration

Spills during exploration are estimated to be small (<1,000 bbl) and would consist of refined oils because crude or condensate oils would not be commercially produced during exploration. Refined oils are used in exploration activities for the equipment (vessels), lubrication, and refueling. Table 3-2 depicts the estimated total number and volume of small spills over the life of the E&D Scenario, as well as annual estimates. During exploration, it is estimated that up to 6 refined oil spills could occur and range in size from <1 bbl to 50 bbl per spill.

Table 3-2: Total and Annual Potential Small Spills throughout Life of the E&D Scenario

Activity	Type of Small Oil Spills	Total Number of Small Spills	Total Volume of Small Spills (bbl)	Annual Number of Small Spills	Annual Volume of Small Spills (bbl)
Exploration Geological and Geophysical Activities	Refined	0–3	0–15	0–1	0–<1 or ≤13
Exploration and Delineation Drilling	Refined	0–3	0–60	0–1	0–<5 or ≤50
Development and Production, Decommissioning	Refined, Crude, or Condensate	0–405	0–310	0–13	0–10

3.1.1.2 Development and Production

An estimated 405 crude, condensate, or refined small oil spills could occur during development, production, and decommissioning (Table 3-2 and Table 3-3). Of those, about 389 are <1 bbl, 14 range from ≥1 bbl up to 50 bbl, and 2 range from ≥50 bbl up to <500 bbl.

Table 3-3: Generalized Size, Oil Type, and Timing of Potential Spill or Release over E&D Scenario Lifespan

Spill Size	Oil Type	Exploration (Years 1-5)		Development and Production (Years 6-13)				Production (Years 14-34)	Production and Decommissioning (Years 35-40)		
		YEARS 1 THROUGH 40									
		1-2	3-5	6	7-8	9-10	11	12-34	35-38	39	40
Small	Refined	G&G Surveys									
			Drilling								
				Development, Production and Decommissioning							
	Crude Condensate				Oil Production						
Large	Crude Condensate				Oil Production						
Large	Diesel				Oil and Gas Development and Production						

3.1.2 Large Oil Spill: ≥1,000 bbl

One large spill of crude, condensate, or refined oil is assumed to occur during development and production activities. This assumption is based on considerable historical data that indicate large OCS spills ≥1,000 bbl could occur during these activities (ABS Consulting, 2016). This assumption is also based on statistical estimates of the mean number of large spills (0.21) from platforms and pipelines, the number and size of large spills on the OCS, and project-specific information in the E&D Scenario.

The assumptions BOEM uses to analyze the potential effects of one large crude, condensate, or refined oil spill are summarized in Table 3-3 and Table 3-4.

Table 3-4: Large Spill Scenario Assumptions

Variable	Assumption for Purposes of Analysis
Number	One large spill occurring during the32 years of oil and gas production (Section 3.1).
Percent Chance of One or More Large Spills Occurring	Percent Chance of One or More Large Spills Occurring: 19% chance of one or more large spills occurring; 81% chance of no large spills occurring (Ji and Smith, 2021).
Activities	A large spill occurs during development or production. No large spill occurs during geological and geophysical activities, exploration and delineation drilling activities, or decommissioning activities.
Timing	A large spill occurs any time of the year. A large crude, condensate, or diesel spill could occur during the 32 years of crude oil, natural gas liquid condensate, or gas production.
Source, Size, and Oil Type	Pipeline or platform 3,800 bbl crude, condensate, or diesel oil.
Medium Affected	Production facility and then the water or ice; open water; broken ice; on top of or under solid ice; shoreline; or snow.
Weathering After 30 days	Condensate and diesel oil will evaporate and disperse much more rapidly than crude oil, generally within 1–10 days. After 30 days in open water or broken ice, BOEM assumes the following weathering for crude oil: 17%–20% evaporates, 19%–80% disperses, and 3%–61% remains.
Chance of Large Spill Contacting and Timing	Time to contact and chance of contact from a large oil spill are estimated from an oil spill trajectory model (Ji and Smith, 2021; Appendix A, Tables A.2-1 through A.2-60). Assuming a large spill occurs, the chance of contact is analyzed from the location where it is highest when determining impacts.
Chance of One or More Spills Occurring and Contacting	The overall chance of one or more large oil spills occurring and contacting is calculated from an OSRA model (Ji and Smith, 2021; Appendix A, Tables A.2-61 through A.2-64).
Spill Preparedness, Prevention, and Response[1]	The OSRA does not account for preparedness, prevention, response, cleanup, or containment and therefore may overestimate the chance of a large spill contacting ERAs, LSs, or GLSs. In BOEM, (2019)[1], Sections 5.3.4 and Section 7 are incorporated by reference and summarized in Appendix A, Section A-1. Spill drills, including GIUEs, response, and cleanup actions could require multiple technologies including surveillance and monitoring, waste management, wildlife response, source containment, and both mechanical and non-mechanical countermeasures. Drills and Spill Response are analyzed in Chapter 4.

Notes: OSRA = Oil Spill Risk Analysis ERA = Environmental Resource Area LS = Land Segment
GLS = Grouped Land Segment GIUE = Government Initiated Unannounced Exercise
[1] Oil Spill Preparedness, Prevention, and Response on the Alaska OCS, OCS Report 2019-006.

3.1.3 Gas Release

Because gas releases are an important concern to stakeholders, BOEM assumes a release will occur and conducts gas release analysis for development and production activities (detailed in Appendix A, Section A-2). For purposes of this environmental document, one loss of well control or one pipeline rupture (offshore or onshore) is assumed over the 32 years of gas production releasing 20–30 million cubic feet of natural gas over one day.

3.1.4 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 here but are not factored into the oil spill trajectory analysis. Information regarding spill drills and spill response found in BOEM's 2019 report *Oil Spill Preparedness, Prevention, and Response on the Alaska OCS,* Section 5.3.4 *BSEE Oil Spill Response Plan Drills,* and Section 7 *Description of Potential Response Actions,* are incorporated by reference and summarized here.

Spill drills, including Bureau of Safety and Environmental Enforcement (BSEE) government-initiated unannounced exercises (GIUEs) and other spill response practices, are considered part of the Proposed Action and are analyzed in Chapter 4. These activities could include oil spill response equipment deployment, vessel 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 to test the operator's incident management team or field deployments of listed spill response equipment to demonstrate equipment and personnel readiness (BOEM, 2019, Section 5.3.4). Offshore spill response efforts could require multiple technologies including surveillance and monitoring, waste management, wildlife response, source containment, mechanical countermeasures, and non-mechanical countermeasures such as dispersants and in-situ burning. Onshore response could include onshore and shoreline assessment; booms, sorbents, and fixed barriers; shoreline flushing and surf washing; surface washing and bioremediation; contaminated substrate, vegetation, or debris removal; and natural recovery. These activities include the use of aircraft, vessels, vehicles, heavy equipment, and various response equipment designed for that activity (BOEM, 2019, Section 7).

3.1.5 Very Large Oil Spill: ≥120,000 bbl

Very large oil spills (VLOS) and gas releases are very low probability, high impact events. Although very unlikely (frequency of spill exceeding 120,000 bbl is >0.00001–<0.0001 per well) and not reasonably foreseeable as a result of the LS 258 Proposed Action or any alternatives, BOEM considered a hypothetical long duration loss of well control resulting in 120,000 bbl of oil and released gas by relying on the analyses completed for the LS 244 Final Environmental Impact Statement (FEIS) (BOEM 2016). This is an appropriate comparison because the lease sale areas are the same in LS 244 and LS 258; the analyses in LS 244 are relatively recent (completed in 2016); and the methodology and assumptions used for the LS 244 VLOS (described in Appendix A, Section A-7, *Very Large Oil Spills*; and Appendix B, *Very Large Oil Spill (VLOS) Estimate for an Exploration Well in the (Federal) Cook Inlet Planning Area, Alaska)* are still applicable and valid. Specifically, information in Section 4.12 of the LS 244 FEIS concluded that the potential effects of a VLOS on environmental, social, and economic resources ranged from minor to moderate for a few resources to major for most resources. Similarly, should a VLOS occur as a result of LS 258, all resources analyzed could be affected and impacts could range from minor to moderate for a few resources to major for most resources.

3.2 Past, Present, and Reasonably Foreseeable Future Activities

Cumulative effects are the incremental environmental impacts of the Proposed Action added to environmental impacts from past, present, and reasonably foreseeable future activities (RFFAs), regardless of the agency (federal or non-federal) or person undertaking such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The cumulative effects assumptions are a description of past, present, and RFFAs that are expected to have impacts that overlap spatially and temporally with impacts from the Proposed Action. Actions considered for analysis include:

- Past, present, and reasonably foreseeable future oil and gas activities that occurred in the past, ongoing activities for which infrastructure exists or is under construction, and future activities for which a formal proposal exists in or near the Proposed Lease Sale Area.
- Past, present, and RFFAs other than oil and gas activities in or near the Proposed Lease Sale Area.

3.2.1 Oil and Gas Related Activities

Oil and gas have been developed and produced in Cook Inlet state waters and onshore for several decades beginning with the Swanson River, Kenai Peninsula (1958), and the Tyonek North Cook Inlet (1962) natural gas discoveries.

Offshore infrastructure was installed in the mid-1960s in Cook Inlet state waters and production has continued since that time. A liquefied natural gas (LNG) export plant was built in Nikiski in 1969 and began supplying natural gas to Japan under export license by the Department of Energy. Cook Inlet was considered a mature oil province that had reached peak oil production of more than 227,000 barrels per day (bpd) in 1970 and peak natural gas production in 1994. Following this period, Cook Inlet Basin's onshore and offshore oil production had declined to 8,900 bpd. However, with the passage of the SOA's Cook Inlet Recovery Act in 2010 and the subsequent entry of Hilcorp Alaska LLC (Hilcorp) into Alaska, Cook Inlet wells have been worked over and production levels have increased since 2011. An abbreviated listing of onshore and offshore past, present, and reasonably foreseeable Cook Inlet oil and gas discoveries and production is located in Table 3-5.

Offshore infrastructure in Cook Inlet includes operational and "light-housed" (currently non-operational) platforms in state waters (Table 3-6). Although some platforms are not currently producing, they are likely to remain in place and in some instances could become operational again (Table 3-6). Other existing infrastructure includes subsea oil and gas pipelines, onshore terminal processing, and support facilities. As of 2019, there were approximately 126 km (80 mi) of subsea oil pipelines and 266 km (165 mi) of subsea gas pipelines in Cook Inlet (ADEC, 2019).

Volumes of historical Cook Inlet gas production in comparison with anticipated LS 258 production are illustrated on Figure 4-2. Currently, Cook Inlet produced gas is consumed by a variety of users in Alaska and natural gas processed liquids go to a storage facility in Kenai (CINGSA, 2016). Gas is transported via onshore distribution pipelines on both the east and west sides of Cook Inlet. Reasonably foreseeable future gas-related projects include the Alaska Stand-Alone Natural Gas Pipeline (ASAP) and the Alaska LNG Project. Each would involve the construction of a gas pipeline from the North Slope to southcentral Alaska and the transport of LNG out of state. The ASAP would terminate at Point Mackenzie in upper Cook Inlet where a new LNG plant would be constructed. Alaska LNG proposes to terminate the new gas line at an LNG plant in Nikiski for shipment out of Alaska.

Historical Cook Inlet crude oil production volumes in comparison with anticipated LS 258 production are illustrated on Figure 4-1. Currently, Cook Inlet crude oil production is piped either to the Trading Bay Production Facility located on the west side of Cook Inlet, or to the Kenai Refinery in Nikiski. Crude oil produced outside Cook Inlet, including limited international crude, is delivered by truck and double-hulled tankers through Cook Inlet and pipelines to the refineries. Wholesale delivery occurs through terminals in Kenai, Anchorage, the Nikiski dock, and the Port of Alaska. Processed fuels are transported by pipeline to the Port of Alaska in Anchorage, the Anchorage International Airport, and for use in a network of fuel stations throughout Alaska. The Drift River Oil Terminal on the west side of Cook Inlet has been closed due to proximity to Mt. Redoubt, an active volcano. Drift River and the associated Christy Lee Loading Platform are scheduled to be decommissioned (RCA, 2018).

Both state and federal oil and gas lease sales have been regularly held throughout Cook Inlet for over 50 years. Six (6) federal oil and gas lease sales have been held in the Cook Inlet Planning Area in that time. The first lease sale in the Cook Inlet Planning Area occurred in October 1977, Sale CI, which 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. Sale 149, held in June 1997, resulted in two leases being issued. Lease Sale 191 (2004) was held but received no bids. Two other proposed lease sales (Sale 211 in 2009, and Sale 219 in 2011) were cancelled due to a lack of industry interest. The most recent lease sale was held in June 2017, Lease Sale 244, which resulted in 14 leases being issued. No production has occurred on the Cook Inlet OCS to date.

As described above and in the tables below, exploration on the OCS and exploration and production in state waters and onshore on both state and federal lands are occurring and are expected to continue throughout the 40-year lifespan of the E&D Scenario associated with the Proposed Lease Sale. Not all exploration activities have led or will lead to resource development. Seismic surveys and exploration are ongoing throughout Cook Inlet and would be expected to continue throughout the 40-year lifespan of the E&D Scenario associated with the Proposed Lease Sale. In 2019 and 2021, Hilcorp conducted exploratory surveys - deep penetrating marine seismic surveys and geohazard surveys, respectively. It is anticipated that data from these surveys would be used support Hilcorp's submission of an Exploration Plan.

Table 3-5: Cook Inlet Onshore and Offshore Oil and Gas Production

Cook Inlet Field / Unit Name	Discovery Year	Production Start	Oil and/or Gas Production	Past	Present	RFFA
Cosmopolitan Unit (Starichkof)	1967	2007	Oil & Gas	x	x	x
Kenai Unit	1961	1961	Gas	x	x	x
Cannery Loop Unit	1979	1988	Gas	x	x	x
Ninilchik Unit	1961	2001	Oil & Gas	x	x	x
Redoubt Shoal Unit	1968	2001	Oil	x	x	x
McArthur River Unit	1965	1967	Oil & Gas	x	x	x
West McArthur River Unit	1991	1994	Oil &Gas	x	x	x
Trading Bay Unit	1965	1967	Oil	x	x	x
North Trading Bay Unit	1965	1967	Oil	x		x
Middle Ground Shoal Unit	1962	1967	Oil	x	x	x
North Middle Ground Shoal Unit	1964	1982	Gas	x		x
Kitchen Lights Unit	2007	Undeveloped	Oil &Gas			x
Granite Point Unit	1965	1967	Oil &Gas	x	x	x
North Cook Inlet Unit	1962	1970	Gas	x	x	x
Beluga River Unit	1962	1968	Gas	x		x

Source: ADNR, ADOG, Activity Map, May 2020.

Table 3-6: Cook Inlet Offshore Oil and Gas Platforms

Cook Inlet Oil and Gas Field	Platform by Name	Oil and/or Gas Production	Year Installed	Cook Inlet Location	Platform Status
Redoubt Shoal Unit	Osprey	Oil	2000	mid-channel, west of Nikiski	In operation
Trading Bay Unit	King Salmon	Oil	1967	west side, adjacent to shore	In operation
	Dolly Varden	Oil & Gas	1967	west side, adjacent to shore	In operation
	Grayling	Oil & Gas	1967	west side, adjacent to shore	In operation
	Steelhead	Gas	1986	west side, adjacent to shore	In operation
	Monopod	Oil & Gas	1966	west side of channel	In operation
North Trading Bay Unit	Spurr	none	1966	west side of channel	Decommissioned
	Spark	none	1968	west side of channel	Decommissioned
Middle Ground Shoal Unit	“A”	Oil	1964	mid-channel	In operation
	Baker	Oil	1965	mid-channel	In operation
	Dillon	Oil	1966	mid-channel	In operation
	“C”	Oil	1967	mid-channel	In operation
Granite Point Unit	Bruce	Oil	1966	west side, adjacent to shore	In operation
	Anna	Oil & Gas	1966	west side, adjacent to shore	In operation
	Granite Point	Oil & Gas	1966	west side, adjacent to shore	In operation
North Cook Inlet Unit	Tyonek/Phillips A	Oil & Gas	1968	mid-channel	In operation
Kitchen Lights Unit	Julius R	Gas only (not within unit)	2016	mid-channel	In operation
Drift River	Christy Lee	none	1965	west side	Decommission pending

Notes: Units listed are offshore in State of Alaska waters.
Source: BOEM Report: “2019, Offshore Platforms Onshore Processing and Support Facilities, Cook Inlet Region, Alaska, Revised Feb. 19, 2020.”

3.2.2 Other Activities

Other activities that could contribute to cumulative environmental impacts include marine transportation, ports and terminals; mining projects; harvest activities; residential and community development; scientific research and survey activities; and military and homeland security activities.

3.2.2.1 Marine Transportation, Ports, and Terminals

Cook Inlet is a regional hub of marine transportation throughout the year and includes six deepwater ports (Anchorage, Port MacKenzie, Nikiski, Homer, City of Seldovia, and Drift River Terminal), and several light-draft ports (e.g., Port Graham, Tyonek, and Williamsport). Nikiski is the second largest port in Alaska by cargo tonnage (AAPA, 2018). The Port of Anchorage, the third largest port in Alaska, is designated a U.S. Department of Defense National Strategic Port and provides services to approximately 75 percent of the total population of Alaska.

The majority of vessel traffic moves along north-south transit lines with deep draft vessels generally using the east side of Cook Inlet. Offshore supply vessels account for much of the commercial large vessel activity outside of the traditional north-south track lines, whereas commercial fishers and suppliers use cross-inlet traffic routes to reduce travel distance from Cook Inlet locales to the Bristol Bay region. Kachemak Bay is a frequent and preferred port of refuge for ships and tugs during bad weather and historically has the highest level of traffic activity in Cook Inlet. When 2010 Cook Inlet vessel traffic statistics were compared against vessel traffic statistics in 2005–2006, only slight changes in the type and number of vessels were observed. Consequently, only nominal increases in Cook Inlet vessel traffic are projected with any significant increase dependent upon substantial improvements to existing infrastructure for extraction of minerals and coal, and construction of an Alaska gas pipeline vessel (Eley, 2012). It is reasonable to forecast that marine traffic activity will remain similarly flat or show slight increase due to relatively stable population and commercial activities (Nuka Research & Planning Group and Pearson Consulting, 2015).

3.2.2.2 Mining Projects

There are a number of mining claims and resources in southcentral Alaska that have been subject to mineral exploration activities. Exploration activities have been intermittent depending on the specific claim or resource. Three proposed mining projects are considered in the cumulative effects analysis: the Donlin Gold Mine Proposed Natural Gas Pipeline, the Diamond Point Rock Quarry, and the Pebble Mine Project.

Donlin Gold Mine Proposed Natural Gas Pipeline

Donlin Gold is an undeveloped gold deposit located in western Alaska's Yukon-Kuskokwim region. Donlin Gold, LLC proposes to construct a 14-inch-diameter steel pipeline to transport natural gas approximately 315 mi from an existing 20-inch pipeline tie-in near Beluga, Alaska to the proposed mine site power plant. Except for two above-ground fault crossings, the pipeline would be buried within an approximately 50-foot right-of-way. The pipeline would be designed to deliver up to 73 million standard cubic feet per day of natural gas at a maximum allowable operating pressure of 1,480 pounds per square inch gauge for 30 years. Electrical power for the compressor station would be supplied by a 25-kilovolt transmission line running north from the Beluga Power Plant to the gas compressor station. U.S. Army Corps of Engineers (USACE) released the Final EIS in April 2018 and, with the Bureau of Land Management (BLM), issued a Joint ROD. State and federal permitting activities are currently in progress.

Diamond Point Rock Quarry

Diamond Point, LLC has proposed to develop a granite quarry at Diamond Head near the convergence of Cottonwood and Iliamna bays on the western shore of Cook Inlet. The project involves modification of the shoreline to construct an access road, breakwater, barge landing, and solid fill dock. Coastal infrastructure includes discharging fill material into 11.42 acres below high tide line for staging equipment, stockpiling aggregate, and barge-loading facilities. Dredging would be required in Iliamna Bay. The 30–40 million cubic yards of hard rock would be a source for infrastructure projects in Anchorage, Kodiak, and the Alaska Peninsula.

Pebble Mine Project

Pebble Limited Partnership (PLP) is proposing to develop a large-scale copper, gold, and molybdenum deposit known as the Pebble Deposit. Located in the Bristol Bay watershed west of Cook Inlet, the proposed project includes an open-pit mine with associated infrastructure; the development of a port, dock, and year-round shore-based facilities located north of Dimond Point in Iliamna Bay on the west side of Cook Inlet; and a transportation corridor that includes a 264-km (164-mi), 30.5-cm (12-in) diameter gas pipeline from the Kenai Peninsula across Cook Inlet to the mine site. In February 2019, the USACE released the draft EIS for the Pebble Project. A final EIS was issued in July 2020. The ROD was issued on November 20, 2020 and found that the mine was contrary to the public interest. The USACE's decision was appealed. The Pebble Mine project is currently on hold due to pending litigation but is included as a pending future project.

3.2.2.3 Harvest Activities

Resource harvest activities, including subsistence, commercial, and sport fishing and hunting, have occurred and will continue to occur throughout lower Cook Inlet. Harvest levels (and therefore their potential to contribute to environmental cumulative effects) will continue to rise and fall and be subject to regulations, co-management, or other decision-making.

3.2.2.4 Residential and Community Development

The 2019 estimated population of the KPB was 58,367. The Alaska Department of Labor and Workforce Development projects modest increases over the next two decades (ADLWD, 2020a). A majority (86 percent) of the land in the KPB is federally or state owned and managed and is not generally available for community development. Borough, city, and private land ownership is concentrated primarily along major road corridors and the towns and cities that are located along the road system, with the exception of Native corporation land holdings (KPB, 2019). Within the area available for development, residential land use dominates interspersed with clusters and individual areas of commercial, industrial, gravel extraction, and agricultural use (KPB, 2019). The planning objectives identified in the *Kenai Peninsula Borough Comprehensive Plan* support future community development that follows these trends (KPB, 2019).

3.2.2.5 Scientific Research and Survey Activities

Scientific surveys and research conducted by government, institutional, and private parties have the potential to disturb wildlife and interfere with subsistence and recreational activities. Animal mark and recapture studies and relocation efforts occur and have the potential to alter wildlife distributions (ADF&G, USFS, and USFWS, 2003; Olson, 2015). Activities conducted by aircraft and vessels typically have created the most potential for conflict with wildlife, but no substantial change in scientific aircraft or vessel activity is anticipated over the timescale of the proposed lease sale.

3.2.2.6 Military / Homeland Security Activities

Joint Base Elmendorf-Richardson (JBER) is located approximately 11 km (7 mi) northeast of downtown Anchorage in the upper Cook Inlet watershed. The 32,306-ha (74,641-ac) facility houses active-duty military personnel including Air Force, Army, Marine Corps, Navy, Army National Guard, Air National Guard, and Coast Guard. Although the various activities at JBER are land- or air-based, they could affect resources in Cook Inlet due to ongoing operations and historical disposal practices (e.g., sites such as Eagle River Flats contaminated by white phosphorus). There is no indication that the military presence at JBER will change in the foreseeable future, so BOEM has assumed JBER activities will continue at current levels.

3.2.2.7 Climate Change

Climate change is important to the cumulative effects analysis because of the potential for the changing climate to influence the established climatic pattern of Cook Inlet. Potential cumulative impacts were considered in the context of a changing climate. A changing climate could contribute to cumulative effects in many ways, including increased noise and disturbance due to increased shipping; increased severity of storms; increase of glacial melting and riverine runoff; increased coastal erosion; drying of freshwater wetlands; decreases in ice cover with the potential for resultant changes in prey-species concentrations and distribution with related changes in species distributions; increased ocean acidity; range extension of species into Cook Inlet; changes in timing and magnitude of plankton blooms; changes in subsistence harvest practices; and changes in potential for community economic development and regional tourism activities. Evidence of warming in Alaska is wide-ranging and includes observed increases in average air and ocean temperatures, melting snow and ice, and sea level rise (IPCC, 2014; NMFS, 2013). Data collected during the past 60 years indicate the state of Alaska has warmed more than twice as fast as the rest of the U.S. with average annual air temperature increasing by 1.7°C (3°F) and warming is expected to continue or accelerate (Chapin et al., 2014; IPCC, 2014; Stewart et al., 2013).

Cook Inlet is a dynamic marine environment where warming is interacting with other complex large-scale environmental processes. Ocean acidification, a decrease in marine pH levels resulting from climate change, is occurring in the North Pacific Ocean, including the Gulf of Alaska (Byrne et al., 2010). A notable marine ecosystem shift occurred in the Gulf of Alaska in the late 1970s, and more marine ecosystem shifts are predicted (Anderson and Piatt, 1999; Litzow, 2006). Warm water anomalies have become increasingly common and larger in scale (Frölicher and Laufkötter, 2018; Amaya et al., 2020). "The Blob," one of the largest marine heatwaves ever observed on Earth, occurred in 2014 to 2016 and stretched from the Gulf of Alaska to the coast of Baja, California (Gentemann et al., 2017; Joh and Di Lorenzo, 2017). Marine heatwaves have been linked to the growth of diatoms and dinoflagellates that produce algal toxins, supporting predictions that harmful algal blooms will be increasingly common (Walsh et al., 2018; Wells et al., 2015; Gobler et al., 2020).

3.3 Regulatory and Administrative Framework

The OCS Oil and Gas Leasing Program is established by OCSLA and the implementing regulations promulgated by BOEM pursuant to its OCSLA authority. Oil and gas activities on the OCS must also comply with other federal, state, and local laws and regulations. Compliance with all applicable laws and regulations is assumed for all action alternatives considered in this EIS. Based on the requirements in the laws and regulations, mitigation can be implemented through binding and enforceable measures known as lease stipulations.

BOEM and BSEE also issue Notices to Lessees and Operators (NTLs), documents that provide clarification, description, or interpretation of a regulation or an OCS standard; provide guidelines on implementation of a special lease stipulation or regional requirement; provide a better understanding of the scope and meaning of a regulation by explaining BOEM's and BSEE's interpretation of a requirement; or transmit administration information. NTLs can be national or regional in scope and can be found on BOEM and BSEE's websites. Existing NTLs applicable to Cook Inlet apply to activities conducted pursuant to LS 258 and are considered part of the Proposed Action and each action alternative.

Additionally, BOEM and BSEE issue Information to Lessees and Operators (ITLs), 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. Existing ITLs applicable to Cook Inlet apply to activities conducted pursuant to LS 258 and are considered part of the Proposed Action and each action alternative.

Post-lease activities resulting from LS 258 will take place pursuant to BOEM regulations governing Ancillary Activities, Exploration Plans, and Development and Production Plans. Post-lease activities will also be covered by certain BSEE regulations and oversight, particularly with regard to platform design and installation and oil spill response. BOEM may require additional post-lease mitigation as part of the environmental review and approval of Exploration and Development and Production Plans. Further mitigation may also be required by the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS) through the ESA Section 7 consultation process. Also, any activities that would incidentally "take" marine mammals are prohibited unless authorized by a Letter of Authorization or an Incidental Harassment Authorization under the Marine Mammal Protection Act (MMPA). These authorizations typically require extensive mitigation measures as described in Section 3.3.2. Mitigation requirements are also 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.

3.3.1 Lease Stipulations

The following proposed Lease Stipulations are considered part of the Proposed Action and would apply to all leases issued under proposed Cook Inlet Lease Sale 258.

Stipulation No. 1 – Protection of Fisheries

Exploration, development, and production operations must be conducted in a manner that minimizes or prevents conflicts with fishing communities and gear (including, but not limited to subsistence, sport, and commercial fishing). To minimize or prevent 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, offshore drilling unit mobilization and location, service vessel routes, and other vessel traffic.

The EP or DPP must 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 minimize or prevent conflicts. The assessment of effects and measures to minimize or prevent conflicts must be described under the environmental impact analysis, as required by 30 CFR 550.227 for EPs and 30 CFR 550.261 for DPPs.

Stipulation No. 2 – Protection of Biological Resources

If biological populations or habitats that may require additional protection are identified by BOEM in the leased area, the Regional Supervisor, Leasing and Plans (RSLP) may require the lessee/operator to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RSLP will provide written notification to the lessee/operator of the requirement to conduct such surveys. Based on any surveys that the RSLP required 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 only during those periods of time, as established by the RSLP, that do not adversely affect the biological resources; and/or 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 the biological resource and protect it 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. The RSLP will provide a written response outlining permissible actions within 30 days.

3.3.1.1 Stipulation No. 3 – Orientation Program

An EP or DPP submitted under 30 CFR 550.211 or 30 CFR 550.241, respectively, must include a proposed orientation program for all personnel involved in the proposed action (including personnel of the lessee's/operator's agents, contractors, and subcontractors).

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 personnel. 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 and Environmental Management System elements 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 such 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.

Stipulation No. 4 – Transportation of Hydrocarbons

Pipelines may 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 environmentally preferable; 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 areas. In selecting the means of transportation, consideration will be given to recommendations of knowledgeable advisory groups within federal, state, and local governments, and industry.

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.

3.3.2 Additional Requirements of NMFS and USFWS Relative to Marine Mammals

NMFS and the USFWS have regulatory responsibilities for marine mammals under the ESA (for those marine mammals listed as threatened or endangered), and for all marine mammals under the MMPA. BOEM's obligation to conduct ESA consultations with NMFS and USFWS generally results in project-specific requirements which would be included as conditions of BOEM's approval. However, if warranted, operators may receive authorization for incidental take under the MMPA. Such authorizations may contain project-specific conditions in addition to the typical/standard measures summarized below that apply to all MMPA authorizations. BOEM’s analyses of impacts to biological resources in this EIS are based on the assumption that these typical measures would be implemented.

3.3.2.1 General Activities

- The operator shall comply with the National Oceanic and Atmospheric Administration’s (NOAA’s) most current Marine Mammal Oil Spill Response Guidelines.
- Protected species observers (PSOs) shall be used where appropriate to monitor for marine mammal presence and take steps to avoid and minimize injury and disturbance.

Noise

- Activities shall be timed and located in a manner that reduces potential marine mammal disturbance.
- Attenuation zones, also termed “safety radii” or “exclusion radii,” shall be established and monitored around noise-producing activities to identify, prevent, and reduce harassment and injury to marine mammals from noise.
- In poor visibility conditions, operational and monitoring adjustments shall be made to increase detection of marine mammals or reduce noise exposure; for example, noisy activities may be halted or postponed.
- When marine mammals are detected outside a vessel’s safety or exclusion radius and are likely to enter the attenuation zone, the vessel’s activities, speed, and/or direct course will be modified to exclude the animal(s) from that zone in a manner that does not compromise human safety.
- Seismic surveys, drilling, or pile-driving shall not begin if marine mammals are in exclusion zones.

Vessel Traffic

- Vessels shall not approach within 91 m (100 yards) of cetaceans or pinnipeds, or 100 m (109 yards) of sea otters, except if necessary to protect the health and safety of the crew.
- Vessels shall be operated at speeds necessary to ensure no physical contact with marine mammals occurs (including prop strikes at startup), and shall reduce speed when near marine mammals, or as weather conditions require, to reduce the potential for collisions.
- Vessels shall not be operated in such a way as to separate marine mammals from their group.
- Vessel operators shall not make multiple changes in direction when within 274 m (300 yards) of marine mammals.
- Vessels shall avoid multiple speed changes; however, vessels should slow down when within 274 m (300 yards) of marine mammals, especially during poor visibility.

Aircraft Traffic

- Aircraft shall operate at least 457 m (1,500 feet) above sea level, except during an emergency or to maintain safety.
- When weather conditions do not allow a 457 m flight altitude, aircraft may be operated at altitudes below 457 m.
- Helicopters shall not hover or circle above marine mammals and shall use prescribed transit corridors.

3.4 Mitigation Measures Proposed

Where appropriate, BOEM also identified mitigation measures which, if implemented for LS 258, would further reduce potential impacts to various environmental resources. These additional mitigation measures are described below and in relevant sections of Chapter 4 to which they apply. BOEM may require additional mitigation as part of the environmental review and approval of proposed EPs and DPPs.

Throughout Chapter 4, BOEM analysts identify and analyze additional mitigation measures which, if implemented through lease stipulations or other mechanisms, would further reduce potential impacts from the activities associated with the E&D Scenario. These additional mitigation measures are described below, and in relevant sections in which they apply.

3.4.1 Birds

3.4.1.1 Habitat Impacts

- To minimize impacts caused by terrestrial habitat alteration: Construction activities and infrastructure, such as pipelines, shall avoid important habitat areas, including estuarine and salt marshes and coastal Important Bird and Biodiversity Areas (IBAs).
- Steps shall be taken to minimize destruction of active nests, eggs, and flightless chicks. These include conducting land clearing in winter prior to the arrival of spring migrants, avoiding land clearing between April 20 and July 15, staging mechanized equipment in winter to deter ground-nesting birds, and/or other measures that achieve the stated goal (USFWS, 2020).

3.4.1.2 Disturbance Impacts

Lighting

To minimize collision impacts to flying birds, including those caused by light attraction, a lighting plan should be developed in cooperation with BOEM, BSEE, and USFWS. The lighting plan would include details on design, installation, and day-to-day operation of lighting on production platforms and large vessels (e.g., marine seismic survey vessels which may be offshore overnight or longer) and incorporate the monitoring and adaptive management strategies listed below:

- Education on lighting attraction and bird collisions shall be provided to relevant contractor/staff.

Where safety allows, the plans shall incorporate the following:

- The number of exterior lights operating at “on” at any one time shall be minimized. Lessees will minimize the use of high-intensity work lights. Exterior lights will only be used as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather; otherwise, they will be turned off.
- Exterior lights shall be down-shielded.
- Black-out curtains shall be used on exterior-facing windows.
- All avian mortalities and collisions (i.e., presence of birds, dead or stranded, that are unable to depart on their own) shall be reported in a timely manner to BOEM and USFWS for use in potential adaptive management strategies. Records shall be kept and reported according to protocols developed in cooperation with BOEM, BSEE, and the USFWS, and the data shall be annually submitted in an electronic format to BOEM and USFWS.

The Plan shall also consider the following for production platforms:

- Green or blue exterior lights shall be used instead of white lights. Green and blue artificial lights have been shown to decrease the number of mortalities among nocturnally migrating birds.

- A strobe-based light-repellant system, similar to that used at the Northstar Unit, shall be designed and implemented for use on production platforms.
- Crane booms shall be lowered when not in use, rather than kept aloft and lighted.
- The height of gas flare booms shall be designed above 20 m (66 ft) (i.e., to include consideration of the mean flight altitude of vulnerable bird species). At-risk birds such as Steller's eider are known to fly relatively low, at about 20 m (66 ft), during migration.
- Flare boom operating procedures shall minimize gas flaring on low visibility nights during the spring and fall passerine and waterbird migration seasons (approximately March 15 to May 30 and July 20 to October 15).
- An adaptive management component shall be included in the monitoring plan for avian mortalities and collisions. At a minimum, the plan shall include daily surveys of the platform for the presence of birds, stranded or dead, and the circumstances of their death. Surveys may be performed in conjunction with other work/surveys. Records shall be kept according to protocols described above under Lighting, and data shall be submitted in a timely manner that allows for potential alteration of identified lighting protocols where safety allows. Surveys shall be conducted until decommissioning is commenced unless all parties (BOEM, BSEE, and USFWS) agree to a different timeline.

Vessel Traffic

- To minimize impacts to nesting seabirds, vessels travelling greater than 5 knots shall not approach within 1 nautical mile (nmi) of all seabird colonies.

Aircraft Traffic

- To minimize impacts to nesting seabirds, where safety allows: Aircraft shall avoid approaching within 1 nmi of any seabird colony April 15 through August 31.

3.4.2 Commercial Fishing

- Prior to commencing an activity, lessees shall coordinate with commercial fishing groups to develop a mutually agreeable plan that minimizes space-use conflicts.

CHAPTER 4: AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

An OCS lease sale provides qualified bidders the opportunity to bid on OCS blocks to gain conditional rights to explore, develop, and produce oil and natural gas. Issuance of a lease does not authorize any exploration, development, or production activities. However, in order to provide the public and decision makers with a picture of the post-lease activities and potential impacts that may occur as a result of the proposed lease sale (Proposed Action), BOEM creates and analyzes an exploration and development scenario (E&D Scenario). The E&D Scenario describes the types of post-lease oil and gas activities that could occur as a result of the proposed lease sale and provides an estimate of their timing, frequency, and duration.

This chapter begins by describing the E&D Scenario. The affected environment, environmental consequences, and cumulative impacts associated with the post-lease activities described in the E&D Scenario follow. The chapter is organized by resource area: physical, biological, and social. Each resource-specific section begins by describing the environment of the area likely to be affected by the post-lease activities described in the E&D Scenario. Impact analyses in this chapter are as specific and quantitative as reasonably possible given the 40-year timeframe of the described post-lease activities. Additionally, climate change is an on-going consideration in these impact analyses given its role in the changing subarctic ecosystem.

For each resource, the Proposed Action is analyzed first and in greatest detail because it includes the entire Proposed Lease Sale Area and encompasses all of the post-lease OCS oil and gas activities considered in the E&D Scenario. In addition to the activities associated with the E&D Scenario, the analysis of the Proposed Action includes a section summarizing the potential impacts of small and large oil spills with associated response, a gas release, and spill drills as described above in the Oil Spills and Gas Release Scenario (and fully considered in Section A-3, Appendix A). Each action alternative is analyzed in comparison to the Proposed Action and is structured to clearly highlight the purposes of and differences between alternatives. To avoid repetition, analysis of the No Action Alternative for all resources is presented in Section 4.16.

Each section ends with an analysis of the potential cumulative impacts of the Proposed Action. Cumulative impacts of the other action alternatives would be similar to the cumulative impacts identified for the Proposed Action because all action alternatives are presumed to entail the same amount of oil and gas activity. Where the selection of an alternative would lead to notable reductions (or other changes) in the Proposed Action’s contributions to cumulative impacts, these instances are noted. To keep the cumulative analysis useful and meaningful, the analysis focuses on activities that are reasonably foreseeable and that overlap geographically and temporally with the impacts of the Proposed Action. The activities considered in the cumulative analyses in Chapter 4 are described in the Past, Present, and Reasonably Foreseeable Future Activities section (Section 3.2).

4.1 Exploration and Development Scenario

Exploration and Development (E&D) scenarios are hypothetical views of future oil and gas activities based upon professional judgment of the geologic features within the area offered for lease coupled with an analysis of current exploration and production activities. E&D scenarios provide a plausible set of post-lease activities that may occur as a result of leasing. The LS 258 E&D Scenario is only one possible view of how the potential resources of the Proposed Lease Sale Area could be developed. It provides a set of activities to frame BOEM’s environmental analyses and to inform decision-makers and the public of potential environmental effects of the Proposed Action (to hold a lease sale). The full E&D Scenario, explaining the bases for the assumptions described in this Chapter is available on BOEM’s website at https://www.boem.gov/ak258/.

The E&D Scenario is based on both modeling and professional judgment of the interpreted geologic features, coupled with an analysis of current and historic exploration and production activities. Scenario estimates for levels of post-lease oil and gas activity are based on interpretation of available geologic data and specific assumptions about the methods required to extract oil and gas from a given number of fields.

The Scenario identifies a range of low, medium, and high hydrocarbon production levels (referred to individually as the low, medium, and high “case”). This range of production and the activities associated with each case provide the basis for the analyses that follow in this chapter. The E&D Scenario considers a range of oil production between 0 and 192.3 MMbbl (million barrels) and a range of natural gas production between 229.5 and 301.9 Bcf (billion cubic feet). The high case assumes production of 192.3 MMbbl of oil and 301.9 Bcf of natural gas.

So as not to underestimate the potential impacts of the Proposed Action, BOEM is analyzing the high case. The tables in this section display the low to high range of activity. Where only one value is provided for a certain activity, it means the same level of that particular activity is expected across the low, medium, and high cases. The E&D Scenario has been used to produce environmental analyses that overestimate, as opposed to underestimate, impacts of the Proposed Action. To that end, the E&D Scenario’s high case describes a level of activity that exceeds what is expected to result from LS 258. For example, the E&D Scenario estimates up to 8 exploration and delineation wells over a 3-year time period; however, a total of only 13 such wells, the result of two lease sales, have been drilled in the Cook Inlet OCS since 1978, with the last well drilled in 1985.

The high case assumes one oil and one gas field are discovered and developed as a result of LS 258. Developing these discoveries is estimated to occur over a 40-year period, and is categorized into three phases: exploration, development and production, and decommissioning.

Figure 4-1 and Figure 4-2 show how the hypothetical oil and gas fields for this scenario compare to producing fields in the Cook Inlet region.

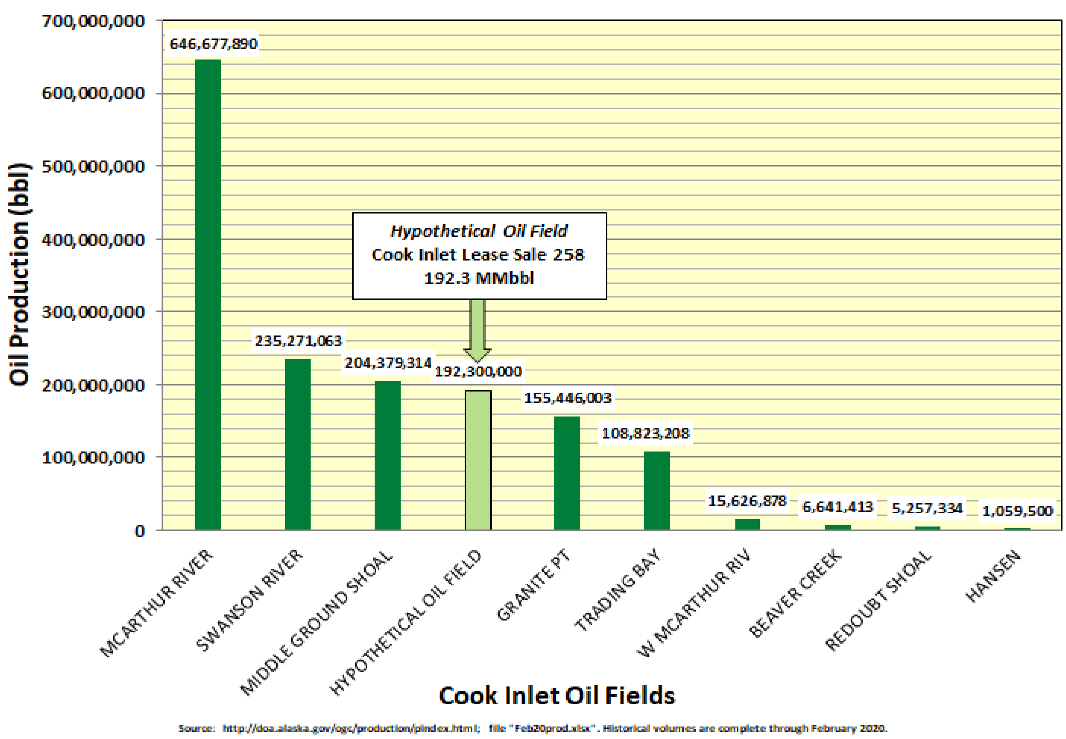
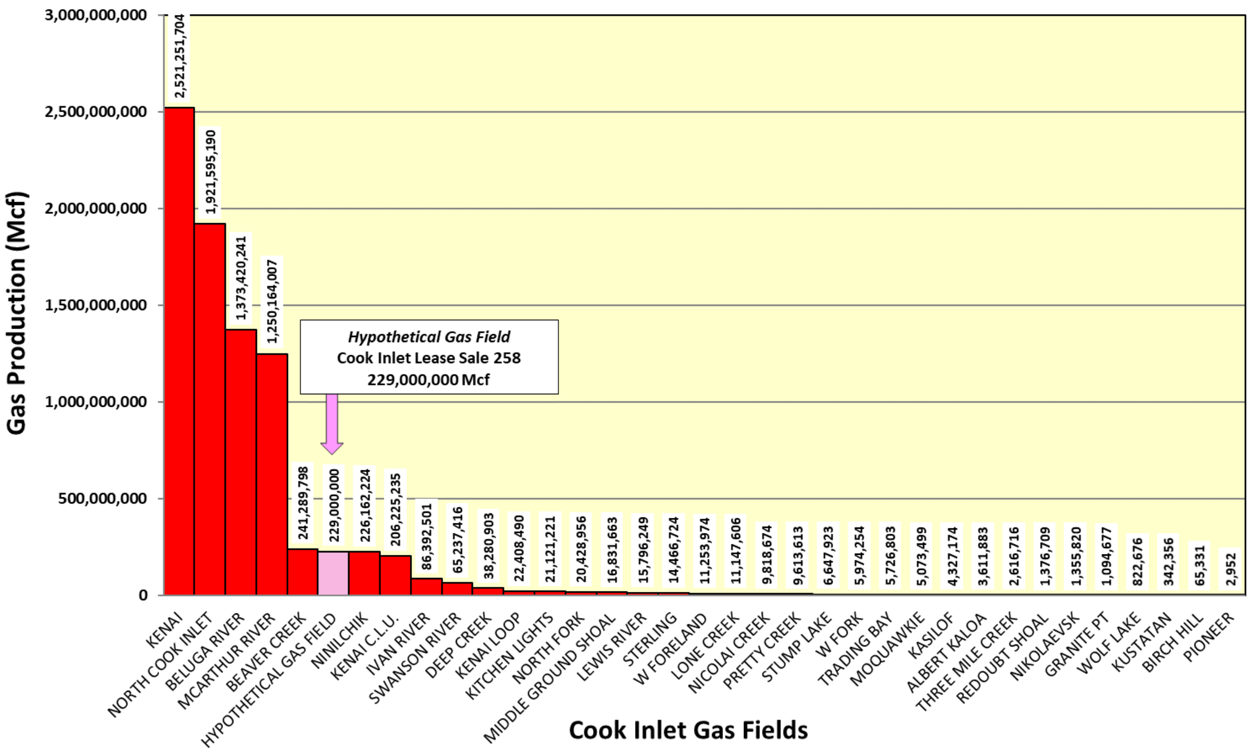


Figure 4-1: Oil Production Assumed in the Lease Sale 258 E&D Scenario’s Medium and High Cases



Note: Cook Inlet Lease Sale 258 (pink bar), in context with historical production from other Cook Inlet gas fields (red bars). Historical production data is from the Alaska Oil and Gas Commission.

Figure 4-2: Gas Production Assumed in the Lease Sale 258 E&D Scenario's Low Case (Gas Only Production)

4.1.1 Exploration Activities

The purpose of exploration activity is to locate and characterize oil and gas fields. Geological and geophysical (G&G) surveys are used to understand seabed and subsurface conditions. Geological surveys consist of bottom sampling and coring. Geophysical surveys include seismic surveys (use reflected sound waves to estimate subsurface properties) and geomagnetic surveys (use magnetic anomalies to locate features). Seismic surveys play the most significant role in supplying data for oil and gas exploration. The E&D Scenario includes the following types of G&G surveys:

1. Seismic Surveys –
    A. Deep Penetrating Marine Seismic Surveys – Used to locate subsurface oil and gas prospects. They are used to cover large areas and map geologic structures on a regional scale. Airguns are the typical sound source for two dimensional (2D) and three dimensional (3D) seismic surveys.
    B. Geohazard Surveys – Used to evaluate potential hazards on the ocean bottom and document any potential cultural resources or benthic communities. The types of equipment used during a typical geohazard survey include echosounders, side-scan sonar, sub-bottom profilers, and boomers.
2. Airborne Geophysical Survey – Used to detect subsurface materials by measuring the earth's magnetic field.
3. Geotechnical Surveys – Used to collect ocean bottom samples to obtain physical and chemical data. The type of equipment used during a typical geotechnical survey includes core sampler, grab sampler, or dredge sampler.

Table 4-1 describes the exploration activities for this E&D Scenario, which represent the following assumptions:

- One deep penetrating marine seismic survey would be conducted to determine the location of prospects for exploration drilling.
- Geohazard and geotechnical surveys characterize individual sites to determine if the seafloor is suitable for exploration and development activity. Multiple sites may be examined in a single survey.
- A mobile offshore drilling unit (MODU) such as a jack-up or drillship would be used for exploration drilling, depending upon availability and site-specific water depths.
- If the exploration wells are successful, delineation wells would be drilled to determine the extent of the field. These wells would also be drilled by MODUs.
- Exploration and delineation drilling operations would take between 30 and 60 days per well depending on the depth of the well, delays during drilling, and time needed for well logging and testing operations.
- Up to three exploration or delineation wells per MODU could be drilled, tested, and plugged during a single drilling season.

Table 4-1: Exploration Activities Assumed in the LS 258 E&D Scenario's Low to High Cases for the Life of the Scenario (40 years)

Element	Number	Line Miles or Area	Season	Comment
Deep Penetrating Marine Seismic Surveys	1	28 Blocks (3D)	Open Water	One 3D seismic survey will be conducted.
Airborne Geophysical Survey	1	1 million acres	Year-Round	Airborne geophysical survey could be conducted over the leasing area.
Geohazard & Geotechnical Surveys	1 to 4	1,403–4,596-line miles and point sampling locations	Open Water	G&G surveys include shallow hazard site clearances (11-36) and point sampling locations. For geohazard surveys, multiple sites may be cleared in a single survey.
Total number of exploration and delineation wells drilled1	3-8	N/A	Open Water	Drilling would be done from MODUs such as a jack-up or drillship.
Maximum number of exploration and delineation rigs in a year	1	N/A	Open Water	Exploration and delineation wells are drilled from the same rig.
Volume of rock cuttings discharged for exploration and delineation wells (cy)2	1,764–4,704	N/A	Open Water	Exploration and delineation wells would average 588 cy of dry rock cutting per well.
Volume of drilling fluids from exploration and delineation wells (bbl)3	27,000–72,000	N/A	Open Water	On average, 9,000 bbl of drilling fluid would be used per exploration well.

Notes: cy = cubic yards bbl = barrels G&G = geohazard and geotechnical N/A = not applicable
[1] All exploration and delineation wells would be permanently sealed with cement.
[2] Cuttings would be discharged in accordance with NPDES permit requirements.
[3] Water-based drilling fluids would be discharged in accordance with the terms of the NPDES permit issued in accordance with the Clean Water Act. Oil-based drilling fluids are not anticipated to be used for exploration drilling.

4.1.2 Development and Production Activities

Development activities include installing production platforms, installing and connecting pipelines to existing onshore pipelines, drilling production and service wells, disposing of drilling wastes, and constructing facilities. Production activities include the processing of produced oil, gas, and water; treatment and reinjection of produced water and gas for reservoir pressure maintenance; facility, well, and process equipment maintenance; and transportation of materials, process waste, and personnel to support these ongoing production activities. Table 4-2 and Table 4-3 describe development and production activities and infrastructure for the LS 258 E&D Scenario based on the following assumptions:

- A reservoir could be discovered and developed at any location leased under this sale.

- Offshore developments resulting from LS 258 would use existing facilities in the Cook Inlet region such as airfields, docks, storage, and processing facilities.
- Production platforms would have a single drilling rig capable of year-round drilling.
- Each platform could have up to 24 well slots, processing equipment, fuel and production storage capacity, and quarters for personnel.
- All processing would be done on platforms; there would be no new onshore processing facilities.
- Produced water would be separated and reinjected into the reservoir using service wells.
- Domestic wastewater from the crew quarters and mess facilities on the platforms would be disposed of in service wells.
- Up to 80 mi of offshore and 80 mi of onshore oil pipelines would be installed to connect the offshore oil field to the oil refinery at Nikiski.
- Up to 120 mi of new offshore gas pipelines would be installed with 1 mile of new onshore gas pipeline installed that would connect to the existing gas pipeline that runs from Homer to Nikiski.

Table 4-2: Development and Production Activities Assumed in the LS 258 E&D Scenario's Low to High Cases for the Life of the Scenario (40 years)

Element	Number	Footprint Area (Acres)	Season	Comment
Production wells	8–81	N/A – area within platform footprint	Year-Round	Production wells area disturbance is included in the platform seafloor disturbance.
Service wells	4–27	N/A – area within platform footprint	Year-Round	Production wells area disturbance is included in the platform seafloor disturbance.
Rock cuttings from production and service wells (cy)	7,056–63,504	0	Year-Round	Production and service wells would average 588 cy of dry rock cutting, which would be disposed in service wells or barged to shore for disposal and established treatment facilities.
Drilling fluids from service and production wells (bbl)	9,360–84,240	0	Year-Round	On average, 2,369 bbls of drilling fluid would be used to drill each production well. 80% of the drilling fluid is expected to be recycled; 20% would be injected into disposal wells or discharged[1].
Steel jacketed platforms installed	1–6	<1	Open Water	0.14-acre footprint/platform (85 ft by 70 ft)
New shore bases	0			
New onshore drilling and production waste handling facilities	0			
Total oil production (MMbbl)	192.3	N/A	Year-Round	
Total gas production (Bcf)	301.9[2]	N/A	Year-Round	
Peak oil rate (Mbbl/day)	36.7	N/A	Year-Round	
Peak gas rate (MMcf/day)	85.64	N/A	Year-Round	

Notes: cy = cubic yard bbl = barrels Bcf = Billion cubic feet MMbbl = million barrels
Mbbl = thousand barrels MMcf = million cubic feet N/A = not applicable
[1] Water-based drilling fluids and cuttings would be discharged under the NPDES permit in accordance with the Clean Water Act. Oil-based drilling fluids are not anticipated to be used for development drilling.
[2] In the high case, the additional gas (72.4 Bcf) is gas associated with the produced oil.

Table 4-3: Pipelines Assumed in the LS 258 E&D Scenario's Low to High Cases for the Life of the Scenario (40 years)

Element	Number	Footprint Area (Acres)	Season	Comment
Onshore Oil Pipeline (mi)	0–80	0–290	Year-Round	Footprint based on an estimated 30-ft. wide disturbance for pipeline installation. Onshore pipeline would be buried where practical.
Onshore Gas Pipeline (mi)	1	4	Year-Round	Footprint based on an estimated 30-ft. wide disturbance for pipeline installation. Onshore pipeline would be buried where practical.
Offshore Oil Pipeline (mi)	0–80	0–291	Open water	Footprint based on an estimated 30-ft. wide disturbance for pipeline installation. Offshore pipeline would be buried where practical.
Offshore Gas Pipeline (mi)	40–120	145–437	Open water	Footprint based on an estimated 30-ft. wide disturbance for pipeline installation. Offshore pipeline would be buried where practical.
New Pipelines to shore	1–2	N/A	N/A	New shoreline crossings of pipelines provided in this table.

Notes: All values are for entire lifespan of the scenario. N/A = not applicable

4.1.3 Decommissioning Activities

Operators would begin well and facility shutdown when income from production no longer covers operating expenses. Decommissioning activities are regulated by BSEE under 30 CFR Part 250, Subpart Q.

- Decommissioning would be completed in stages with hub platforms remaining in service the longest, because production would continue to flow through them from satellite platforms to nearshore facilities.
- Wellhead equipment would be removed, and wells would be permanently plugged with cement. Processing modules would be moved off the platforms.
- Subsea pipelines would be decommissioned by cleaning out inner diameter, plugging both ends, and leaving them buried in the seabed.
- Platforms would be disassembled and removed from the area and the seafloor site restored to a practicable predevelopment condition.
- Any seafloor or terrestrial disturbance would be reclaimed per standards of the applicable land management agency.
- Post decommissioning geohazard surveys would be required to confirm that no debris remains, and pipelines were decommissioned properly.

4.1.4 Transportation

The E&D Scenario includes assumptions about transportation for the entire lifespan of the scenario. Personnel and materials would be transported to exploration and production sites by helicopter, and/or marine supply vessels from an existing onshore base or dock. The highest number of trips by helicopter or supply vessel would occur during platform installation (development) and then during decommissioning. Supply vessel trips may drop to two per week per platform during normal production operations. Table 4-4 describes transportation activity assumptions used for the effects analyses.

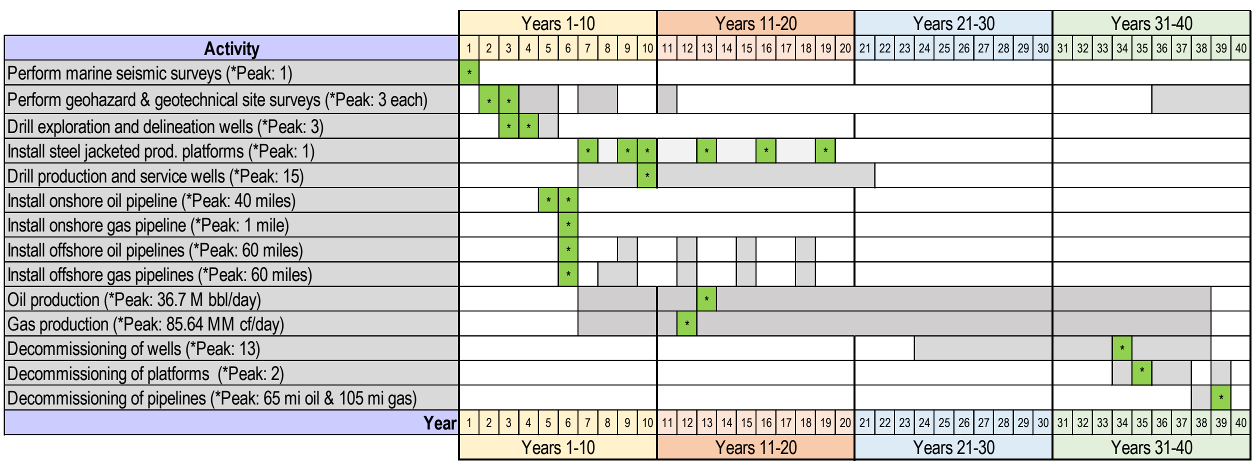
Table 4-4: Transportation Activities Assumed in the LS 258 E&D Scenario's Low to High Cases for the Life of the Scenario (40 years)

Element	Number of Activities	One Way Distance (Miles)	Season	Comment
Flights per week during peak exploration activity	14	700[1]	Year-Round	Approximately 2 flights per day. Flights would depart from Homer or Nikiski.
Boat trips per week during peak exploration activity	5	250[1]	Open Water	Vessels would depart from Homer.
Flights per week during peak development, production, and decommissioning phases	7–42	350–2,100[1]	Year-Round	One flight could service multiple platforms. Number of platforms range from 1-6. Flights would depart from Homer or Nikiski.
Boat trips per week during peak development, production, and decommissioning phases	7–42	350–2,100[1]	Open Water	Number of platforms range from 1 – 6. Vessels would depart from Homer.

Notes: All values are for entire lifespan of the scenario.
[1] Estimates use 50 mi as the typical distance traveled.

4.1.5 Schedule of E&D Scenario Activities Over Life of Field

Exploration, development and production, and decommissioning activities would occur over the 40-year lifespan of the E&D Scenario as shown in Figure 4-3. The range of years depicted for a given activity covers the number of years in which the activity could occur, although activities may not occur in each year within the range. Peak activity is the highest maximum number of occurrences within a year. For example, no more than three geohazard and geotechnical surveys (Table 4-1) would occur in any one year.



Notes: Maximum number of occurrences for each activity in given year.
Gray shaded areas denote years of activity.
Green squares with * denote years of peak activity.

Figure 4-3: E&D Scenario Schedule and Peak Activity

4.2 Impact Scale

The analyses in Chapter 4 apply a scale to categorize the extent of potential impacts to specific resources. The scale considers 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).

Subject matter experts used the best available information and their professional judgment to determine where a particular effect falls in the continuum on a relative scale from "negligible" to "major." For biological resources, impacts were determined based on changes in the stock or population, rather than the individual level.

The impacts scale applied in this 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; and
- Major: Impacts are severe.

In applying this scale and the terms that describe impact categories (levels of effect), subject matter experts considered the unique attributes and context of the resource being evaluated. For example, in considering impacts to biological resources, attributes such as the distribution, life history, and susceptibility of individuals and populations to impacts were considered. 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 severe, and thus, major, 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 Air Quality

4.3.1 Affected Environment

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 EPA to set National Ambient Air Quality Standards (NAAQS). The NAAQS set limits or criteria for ambient air concentrations of six "criteria" pollutants – sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter (PM) (PM_{10} and $PM_{2.5}$), and lead (Pb) (Title 40 CFR 50), which are considered harmful to public health and the environment at concentrations that exceed the NAAQS (EPA, 2015c). The NAAQS represent 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 EPA also sets Prevention of Significant Deterioration (PSD) increments. A PSD increment is the amount of pollution by which an area is allowed to increase without clean air deterioration to the level set by NAAQS. While PSD increments are used by the EPA when evaluating new industrial facilities, it is used here as a proxy metric to ensure that there is no significant impact to air quality.

The air quality agencies of each coastal State have regulatory authority that extends from its "normal baseline" outward to the sea, lakes, and bays, up to 12 nmi (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 3 nm from the baseline (coastline) (5 AAC 09.301). For the Cook Inlet region, EPA maintains jurisdiction to control air pollution from OCS sources located within 25 nm of the SSB (CAA Sec. 328(a) and 42 USC 7627), which for Alaska extends to a point 28 nm seaward from the baseline. Within this area of water, EPA must attain and maintain federal and state ambient air quality standards and comply with the provisions of Section 328 of the CAA (42 USC 7627).

The State of Alaska regulates air quality over the land area surrounding the waters of 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 USC 7407 (40 CFR 81.54 and ADEC 18 AAC 50.020, Table 2). The Cook Inlet AQCR includes all of the Municipality of Anchorage, the Kenai Peninsula Borough (KPB), and the Matanuska-Susitna Borough. Thus, the EPA regulations applicable to the corresponding onshore area 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 unclassifiable, is defined in Sec. 107 of the CAA (42 USC 7407). BOEM assumes that EPA modeling and permitting requirements would bet met.

The CAA also gives special air quality and visibility protection to national parks and wilderness areas larger than 6,000 and 5,000 acres, respectively by allowing their designation as “Class I” areas. The Tuxedni Wilderness area within the Alaska Maritime National Wildlife Refuge is a 5,564.8-acre area located on Chisnik Island and Duck Island in Cook Inlet, adjacent to the Proposed Lease Sale Area. It is the only Class I area in the region.

Within the Cook Inlet AQCR, a portion of the Anchorage urban area located 160.9 km (100 mi) northeast of the Proposed Lease Sale Area is designated a serious maintenance area for emissions of carbon monoxide. In addition, 2.4 km (1.5 mi) northeast of Anchorage, the community of Eagle River is a moderate maintenance area for emissions of PM_{10} (EPA, 2015a and 2016; ADEC, 2016c). No other nonattainment area or maintenance area for any other criteria pollutant is located within the Cook Inlet AQCR. Maintenance areas are those areas with a past violation of air quality standards that has been corrected, and which have since maintained the standard. These ‘maintenance areas’ remain under evaluation for 10 years. Background concentration of pollutants in the Cook Inlet OCS area and surrounding coastal area in comparison to the NAAQS and State of Alaska air quality standards are shown in Table 4-5. Currently, the air quality on the Kenai Peninsula meets, or is cleaner than, the NAAQS.

Table 4-5: Background NAAQS Concentrations in Proposed Lease Sale Area

Pollutant	Averaging Period	Primary NAAQS	Alaska AAQS	Alaska LNG – Nikiski, Alaska	Percentage of the Standard
Nitrogen Dioxide (NO_x)	1 hour	188 μg/m³	188 μg/m³	30.6 μg/m³	16.3
	Annual	100 μg/m³	100 μg/m³	2.6 μg/m³	2.6
Sulfur Dioxide (SO_2)	1 hour	196 μg/m³	196 μg/m³	4.3 μg/m³	2.2
	3 hours	N/A	1,300 μg/m³	N/A	N/A
	24 hours	N/A	365 μg/m³	N/A	N/A
	Annual	N/A	80 μg/m³	N/A	N/A
Particulate Matter (PM_{10})	24 hours	150 μg/m³	150 μg/m³	30 μg/m³	20
Particulate Matter ($PM_{2.5}$)	24 hours	35 μg/m³	35 μg/m³	12 μg/m³	34.3
	Annual	12 μg/m³	12 μg/m³	3.7 μg/m³	30.8
Carbon Monoxide (CO)	1 hour	40,000 μg/m³	40,000 μg/m³	1,145 μg/m³	11.5
	8 hours	10,000 μg/m³	10,000 μg/m³	1,145 μg/m³	11.5
Ozone (O_3)	8 hours	140 μg/m³	140 μg/m³	94 μg/m³	67.1

Source: AAQS = Ambient Air Quality Standards
ADEC Industrial Data Summary, 22 May 2018 (https://dec.alaska.gov/air/air-monitoring/data-summaries;
AK LNG, Nikiski data: https://dec.alaska.gov/media/9162/industrial-data-summary052218.xlsx)

4.3.2 Environmental Consequences of the Proposed Action

Combustion of fuels, primarily diesel, is the primary source of air quality impacts associated with post-lease activities conducted as a result of LS 258 as described in the E&D Scenario. The primary emissions contributor from post-lease activities would be diesel-powered generators from vessels, drill-ships, and platforms. Emissions from diesel combustion would locally and temporarily increase the concentrations of NOx, CO, and $PM_{2.5}$ and PM_{10} (including black carbon).

The secondary contributor of combustion emissions from post-lease activities associated with the lease sale would be natural gas combustion. Once facilities have started producing natural gas from their reservoirs, many operators would likely change from diesel powered generators and engines to natural gas turbines and engines. Also, as a safety precaution, facilities conducting well operations would start and maintain a natural gas flare pilot light once in close proximity to the reservoir. The emissions from natural gas combustion would locally and temporarily increase the concentration of $PM_{2.5}$ and PM_{10} (including black carbon), although at lower levels than those produced by diesel combustion.

Other sources of emissions that have the potential to impact air quality are aircraft landing and takeoff operations. Emissions from aviation fuel combustion would briefly increase the concentrations of CO, NOx, and oxides of sulfur (SOx) in the immediate area around the helipads/landing areas.

Not all sources of emission are solely attributed to combustion. Emissions could also be released from leaking or evaporation during venting, storage, and transport of crude oil. These emissions would allow some volatile organic compounds (VOCs) to escape. VOCs are not listed as a criteria pollutant. However, in the presence of NOx and other environmental factors (sunlight, heat), VOCs could lead to the formation of O_3 which has the potential to impact air quality.

Using its Revised Offshore Economic Cost Model (OECM), BOEM quantified (in tons) the criteria pollutants and greenhouse gases (GHG) estimated to be released over the projected lifetime of the post-lease activities associated with the proposed lease sale, as described in the E&D Scenario. This allowed BOEM to conduct an air quality impact analysis at the lease sale stage of potential oil and gas development when there is not yet an EP or DPP to analyze. Second, BOEM compared these results to those emissions previously estimated for the most recent lease sale in the Cook Inlet Planning Area (Lease Sale 244). BOEM determined that, despite differences in emissions estimates between LS 258 and LS 244, the existing dispersion modeling that had been conducted for LS 244 used assumptions that were conservative and appropriate and would yield an informative analysis of potential impacts. Dispersion modeling takes the estimated gross emissions (tons) and considers weather patterns for the area to estimate the concentration of pollutants at the shoreline. These results can then be compared against the NAAQS to determine the impacts of emissions from the activities considered. Therefore, the dispersion modeling analysis descried in the LS 244 FEIS, Section 4.3.1.1, is being incorporated by reference and summarized below (BOEM, 2016a).

Table 4-6 lists the results from the OECM analysis which quantified the amounts of emissions of pollutants, including GHG, estimated to result from proposed LS 258, as well as those emissions previously estimated for LS 244. The table illustrates that proposed LS 258 is estimated to produce more emissions of NOx, CO, and VOCs, and less emissions of SOx and PM than those estimated for LS 244 over the projected lifetime of post-lease activities associated with each sale. Proposed LS 258 also cuts projected GHG emissions by over 9 million metric tons.

Table 4-6: Estimated Emissions from LS 258 and LS 244

Criteria and Precursor Pollutants	Emissions LS 258 (short tons)	Emissions LS 244 (short tons)	Difference (short tons)
NOx	51,809	44,152	7,657
SOx	1,497	8,566	(7,069)
PM_{10}	889	1,869	(980)
$PM_{2.5}$	82	1,827	(965)
CO	22,893	12,109	10,784
VOCs	25,502	17,490	8,012
Greenhouse Gases			
N_2O	192	3,364	(3,172)
CH_4	69,619	1,021,346	(951,727)
CO_2	8,497,554	16,624,793	(8,127,239)
Total CO_2e	8,567,365	17,649,503	(9,082,138)

Notes: Numbers in parentheses indicate a decrease in short tons. Greenhouse gases are presented in metric tons.

As stated above, dispersion modeling was conducted for LS 244 in 2016. The model used was 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. Because of the relatively short time span (~4 years) between LS 244 and this proposed lease sale, the OCD Model and its meteorological inputs were considered valid for use for this proposed lease sale. The dispersion modeling completed for LS 244 used geographic locations for emissions sources that estimated the maximum potential impact on the sensitive Class I Area of Tuxedni Wilderness and the remaining onshore areas near the proposed lease area. It is important to note that the lease sale area for each of the two lease sales, LS 258 and LS 244, is identical; however, there are differences in E&D scenarios, available blocks, and the numbers of surveys.

The highest, most conservative, potential impacts on the Class I and onshore areas were simulated by placing emission sources in the northwestern corner of the Proposed Lease Sale Area, approximately 6 km (3.7 mi) from the Tuxedni Wilderness, Alaska Maritime National Wildlife Refuge. Emissions from exploration drilling ships while secured to the seafloor, and all platform operations, were modeled as stationary point sources. Modeling considered emissions from facilities and thus did not include emissions projected to occur from the operations of vessels continuously underway, such as support vessels and aircraft traveling across the program area to and from platforms and drilling ships. Vessel and aircraft traffic would 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 in the case of stationary sources.

Table 4-7 and Table 4-8 show the maximum increases in pollutant concentrations estimated from dispersion modeling. The emission impacts shown on these tables are the impacts resulting from the highest activity year. The dispersion modeling conducted under LS244 was separated between exploration and production activities. The results also show the increase of pollutant concentrations in the ambient air onshore, offshore, and at the Tuxedni Wilderness area. As previously mentioned, the PSD increment is the amount of pollution by which an area is allowed to increase without clean air deterioration to the level set by the NAAQS. PSD increments, while used by the EPA for new industrial facilities, are used here as a proxy metric to ensure there is no substantial impact to air quality.

The onshore results from Table 4-7 and Table 4-8 show offshore exploration and production activities would not be expected to lead to any onshore area exceedance of the NAAQS/AAAQS. However, results from Table 4-7 and Table 4-8 show that the incremental impact from modeling at the Tuxedni Wilderness Class I area was larger than the PSD Class I Increment. Because of this, there is a chance that an operator proposing exploration or development and production activities associated with LS 258 may be required to obtain an EPA PSD permit for a Class I area and submit their air quality analysis to the USFWS for review.

Class I areas are also subject to visibility protections to ensure the preservation of the viewshed. To assess potential impacts to visibility in the Tuxedni Wilderness area, the Visibility-Screening Model VISCREEN was applied as part of the LS 244 dispersion modeling. Model results indicated that for an exploration project located 12 km (7.5 mi) away from the Tuxedni Wilderness area, the visibility screening criteria are exceeded in situations 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 the 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 percent of the time. For distances greater than 50 km (31 mi), the visibility screening criteria were not exceeded, and it is presumed a plume would not be visible at that distance.

Table 4-7: Highest Predicted Concentrations* – Exploration Phase of LS 244 E&D Scenario

Year	Offshore	Tuxedni Wilderness Class I Area	Onshore Area	PSD Class I Increments	PSD Class II Increments
Annual Avg. NO_2	6.957	2.45	0.196	2.5	25
Annual Avg. SO_2	0.115	0.04	0.003	2	20
Max. 24-hour SO_2	1.614	0.363	0.068	5	91
Max. 3-hour SO_2	5.599	1.125	0.023	25	512
Annual Avg. PM_{10}	0.823	0.29	0.023	4	17
Max 24-hour PM_{10}	11.59	2.608	0.487	8	30

Notes: * Pollutant Concentrations are shown in µg/m^3.

Table 4-8: Highest Predicted Concentrations* – Production Phase of LS 244 E&D Scenario

Year	Offshore	Tuxedni Wilderness Class I Area	Onshore Area	PSD Class I Increments	PSD Class II Increments
Annual Avg. NO_2	2.959	1	0.083	2.5	25
Annual Avg. SO_2	0.003	0.001	0.0001	2	20
Max. 24-hour SO_2	0.039	0.009	0.002	5	91
Max. 3-hour SO_2	0.137	0.027	0.011	25	512
Annual Avg. PM_{10}	0.254	0.09	0.007	4	17
Max 24-hour PM_{10}	3.58	0.806	0.15	8	30

Notes: * Pollutant Concentrations are shown in µg/m^3.

4.3.2.1 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on air quality are described in Section A-3.1 of Appendix A. 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, potentially causing localized air quality degradation due to increases in VOCs. 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.

Although unlikely, for purposes of analysis, BOEM has considered the effects of a large spill involving a platform or pipeline. The impact on air quality from such a spill would be due to the evaporation of VOCs from the oil on the water. When combined with prior emissions of NOx, the formation of ozone would be possible. 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. Temporary and localized to long-lasting and widespread, and therefore minor to moderate, impacts to onshore air quality could occur under these circumstances.

Similarly, a large gas release could result in degraded air quality in the immediate vicinity of the release. Blowouts of natural gas condensates that did not burn would be dispersed rapidly at the blowout site; and air quality impacts would be considered minor to moderate.

4.3.2.2 Conclusion

Impacts from post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, accidental small spills, and spill drills, would be minor. Although production platforms would be physically present for decades, impacts to air quality resulting from the emissions of those platforms would dissipate as the emissions mix with the surrounding air masses, reducing the overall impact. The air quality in the areas surrounding these activities would recover and return to pre-activity levels within weeks or months after the completion of the activity. A large oil spill may increase impacts to air quality, depending on the size and proximity to shore, because a large spill close to the shoreline could expose population centers to higher levels of VOCs and other pollutants. The post-lease activities described in the E&D Scenario could have minor to moderate impacts on air quality when impacts from a large oil spill are considered.

4.3.3 Environmental Consequences of the Alternatives

Potential impacts on air quality under all action alternatives would not differ substantially from those described for the Proposed Action. These alternatives would not change the total level of activity under the E&D Scenario, and none of the restrictions identified in these alternatives would be expected to change the likelihood or severity of impacts on air quality. Consequently, impacts of these alternatives on air quality would be the same as those for the Proposed Action — minor for E&D Scenario activities, accidental small spills and spill drills, and minor to moderate with the addition of a large spill.

4.3.4 Cumulative Effects

Past, present, and reasonably foreseeable future activities that could affect air quality include oil and gas operations, large oil spills, anticipated growth in vessel and aircraft traffic, national security activities, and regional recreation and tourism, as well as climate change. These activities each represent potential onshore or near-shore sources of air emissions. Emissions from past actions would already have dispersed throughout the atmosphere and would no longer contribute to cumulative impacts.

The present and RFFAs each represent potential onshore or near-shore sources of air emissions. These include both stationary and mobile sources, such as industrial facilities, vessels, and vehicles. Currently, emission sources in and around the area do not produce levels that cause an exceedance or violation of NAAQS. This is because air quality effects would not be additive due to rapid dispersion and diffusion with surrounding clean air, meaning the impact is less than the sum of the individual effects. The impacts stemming from activities described in the E&D scenarios in both LS 244 and 258 are also not synergistic or additive.

Although some activities could occur at the same time, they would not occur in the same vicinity. This is because lease blocks are approximately ~14.5 km (9 square mi) in size, and operators typically do not lease blocks adjacent to other operators. Consequently, it is unlikely that there would be two independent exploration or production operations occurring close enough for emissions to have a synergistic effect. Furthermore, since these sources are not likely to be emitting within the same space, their emission plumes would not have an opportunity to combine and raise concentrations to a higher level.

A large oil spill may have minor to moderate impacts on air quality. These impacts to air quality may overlap with reasonably foreseeable future activities, thereby increasing the overall level of effect expected. The magnitude of this increase, however, depends heavily on the circumstances, such as time of year, type of activity, and/or size of the spill(s), but short-term changes in air quality may occur.

Climate change can also affect air quality by increasing ambient air temperatures and weakening global circulation. Higher water vapor content (due to higher temperatures) is expected to decrease the ozone background concentrations. Particulate matter (including black carbon) is “much more complicated and uncertain than ozone.” (Jacob and Winner, 2009). Although black carbon is a small portion of the $PM_{2.5}$ spectrum, it is a contributor to climate change. Changes to global circulation may lead to localized changes in precipitation levels, in some cases, this would lead to wetter than normal conditions, and in others, drier. Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario may have an additive effect when considering the on-going impacts of climate change.

Impacts to air quality from past, present, and reasonably foreseeable future actions are negligible. When the potential effects of post-lease activities associated with the E&D scenario are considered along with the on-going effects of climate change, potential impacts would be minor. Additionally, it is not anticipated that there would be a violation of NAAQS.

4.3.5 Lifecycle Greenhouse Gas Emissions and Social Cost of Greenhouse Gas Emissions

4.3.5.1 Lifecycle Greenhouse Gas Emissions

Anthropogenic emissions of GHGs are the main contributor to climate change. BOEM recognizes the global scope of the impacts of GHG emissions, and the effects of agency actions that contribute to global concentrations of those GHGs. The activities associated with the Proposed Action would result in GHG emissions from upstream as well as mid- and downstream activities. Upstream activities include the exploration, development, and production described in the E&D Scenario. Mid- and downstream activities are associated with the transportation, refinement, and consumption of the fuels produced from leases issued via LS 258. Each type of activity would create GHG emissions, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These GHG emissions would contribute to climate change globally. The analysis below quantifies projected GHG emissions that would occur from the Proposed Action and the consumption of the produced fuels. These projected GHG emissions serve as a proxy for assessing the Proposed Action's contribution to climate change globally.

The GHG analysis also estimates GHG emissions associated with the No Action Alternative. Under the No Action Alternative, there would be no development or production activities as a result of this lease sale and no oil and natural gas attributable to LS 258 would be transported or consumed. However, in the absence of production stemming from LS 258, demand for oil and gas would not disappear. Rather, it is fulfilled from alternative sources, which we refer to as “substitute” sources. This substitution does not occur on a 1:1 basis (a concept known as “perfect substitution”) because the lack of production from LS 258 would correspond with an estimate of slightly higher prices (and slightly lower demand). BOEM’s analysis of the No Action Alternative thus reflects the energy sources estimated to substitute for oil and gas that would have been produced under the E&D scenario for LS 258, along with the GHG emissions associated with consuming those substitute energy sources. The No Action Alternative lifecycle GHG emissions are those generated from the substitute fuels that are produced and consumed in the absence of LS 258. Alternatively stated, these sources are displaced with LS 258 oil and gas production. BOEM’s modeling suggests that the substitute fuels are primarily additional oil imports and domestic onshore natural gas production.

BOEM is able to model domestic energy markets with sufficient reliability to estimate the energy substitutes consumed or produced domestically. While changes in foreign energy consumption and production would also occur, global energy markets cannot be modeled to the same level of detail as the domestic energy sources. BOEM’s GHG analysis has been updated specifically for this lease sale EIS to include a newly developed quantitative analysis of the Proposed Action’s impact on foreign oil consumption and the resulting GHG emissions under the No Action Alternative. This addition aligns with the courts’ decisions in both CBD v. Bernhardt, Case No. 18-73400 (9th Cir. 2020) (“Liberty”) and CBD v. BLM, Case No. 3:20-cv-00308-SLG. In both cases, the court’s decision directed the corresponding agency to include a quantitative assessment of GHG emissions resulting from shifts in foreign consumption attributable to the Proposed Action or to explain why such quantitative assessment could not be done.

Since issuance of these decisions, BOEM has evaluated its methodology to determine whether a quantitative analysis is possible. This analysis for LS 258 is BOEM’s first GHG analysis to include a quantification of GHG emissions from foreign consumption. This is a new and evolving process, and BOEM will continue to evaluate the methodology and analysis. BOEM seeks comment and feedback from stakeholders regarding its methodology and analysis. As applicable, BOEM will incorporate new information for inclusion in its analysis for the Final EIS. No new data or capabilities have been made available to BOEM since the Liberty decision. One of the reasons BOEM did not previously prepare a quantitative analysis was the lack of information on foreign consumption of petroleum products. To address that data gap and prepare this quantitative analysis, BOEM has used a single generic emissions factor as described below, in place of specific emissions factors for the different types of petroleum products consumed.

The resulting LS 258 analysis indicates that selection of the No Action Alternative results in lower GHG emissions than would be emitted under the Proposed Action when considering only emissions associated with domestic consumption and production and also when the analysis is expanded to consider global impacts. BOEM then calculated the social costs of GHG emissions to estimate the monetized costs associated with the No Action Alternative and the Proposed Action.

Lifecycle Greenhouse Gas Methodology

BOEM's Lifecycle Greenhouse Gas Methodology is described in the paper OCS Oil and Natural Gas: Potential Lifecycle Greenhouse Gas Emissions and Social Cost of Carbon (Wolvovsky and Anderson, 2016[2]). The GHG model was developed to examine the lifecycle GHG emissions associated with OCS oil and gas development activities both pre- and post-production. This includes all operations on the OCS associated with oil and gas leases (exploration, development, and production). The analysis relies on three BOEM models to estimate results: the Market Simulation Model[3] (MarketSim)[4] (Industrial Economics Inc., 2017), The Offshore Environmental Cost Model (OECM) (Industrial Economics Inc. and SC&A, 2018a, b), and the Greenhouse Gas Lifecycle Model (Wolvovsky and Anderson, 2016). For a full description of these models, please refer to their documentation and associated reports, available on BOEM's website.

BOEM acknowledges that these models were developed for analysis at a national level for the National OCS Oil and Gas Leasing Program and that there may be limitations on the scalability of the models to this regional analysis. However, the models incorporate a regional framework and specify assumptions by planning area (e.g., Cook Inlet) when applicable. The models represent the best science and methodology available for estimating energy market impacts and substitution rates, which are important factors in the larger analysis and comparison of GHG emissions that would occur under the No Action Alternative and the Proposed Action, respectively.

When estimating emissions, BOEM's models quantify the three main GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). To provide a single metric for estimating an action alternative's emissions profiles, BOEM provides combined totals of all three GHG emissions in CO_2 equivalent, or CO_2e. This allows for a direct, aggregate, comparison between emissions of different pollutants which have varying potentials to trap heat as well as different atmospheric lifespans. For example, emission of one metric ton of CH_4 has an impact similar to 25 metric tons of CO_2. EPA's (2015) conversion factors are used (see Table 4-9).

2 The GHG model integrates the output from the MarketSim and OECM, as well as mid- and downstream estimated oil and gas production to produce an estimate of lifecycle GHG emissions. See: OCS Oil and Natural Gas: Potential Lifecycle Greenhouse Gas Emissions and Social Cost of Carbon (Wolvovsky, E. and W. Anderson, 2016). Available online at: https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/Leasing/Five-Year- Program/2012-2017/BOEMOceanInfo/ocs_oil_and_natural_gas.pdf.

3 See MarketSim documentation at: https://espis.boem.gov/final%20reports/5612.pdf

4 Elasticity values that have been updated since the 2017 MarketSim documentation are published on BOEM's website at: https://www.boem.gov/oil-gas-energy/energy-economics/national-ocs-program.

Table 4-9: Global Warming Potential in Metric Tons

Greenhouse Gas	CO_2	CH_4	N_2O
Global Warming Potential (CO_2e)	1	25	298

Source: EPA, 2015

BOEM evaluates lifecycle GHG emissions assuming annual exploration, development, and production estimates are produced as estimated under the high activity case described in the LS 258 E&D Scenario. To estimate the energy market substitutions that would occur in the No Action Alternative, BOEM uses the MarketSim. The substitute estimates are then used as inputs in the OECM and GHG Model.

MarketSim is a Microsoft Excel-based model for the oil, gas, coal, and electricity markets that is calibrated to a special run of the U.S. Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) from the 2020 Annual Energy Outlook reference case. The run includes no new OCS lease sales after 2022.[5] Removing the EIA's expectation of future OCS leasing and production allows investigation of alternative new OCS leasing scenarios within the EIA's broad energy market projection. MarketSim makes no assumptions about future technology or policy changes other than those reflected in the EIA NEMS forecast.

MarketSim takes the estimated production from the LS 258 Proposed Action high activity case and adds it to the baseline (the No Action Alternative). MarketSim then evaluates a series of simulated price changes until each fuel market reaches equilibrium where supply equals demand. MarketSim uses price elasticities derived from NEMS runs, peer-reviewed studies, and input from experts to quantify the potential effects on prices, energy production, and consumption over the Proposed Action's period of production.

MarketSim's modeling of oil, natural gas, coal, and electricity for U.S. markets accounts for substitution between alternate fuel sources. It incorporates feedback effects among the markets for substitute fuels using cross-price elasticities between the fuels. For instance, additional natural gas production leads to reduced gas prices. With a reduced price, there is an increase in the quantity of gas demanded. The increase in natural gas quantity demanded then decreases the demand for other fuels like coal. The model also then considers the resulting decrease in the price of coal which dampens the initial increase in the quantity of gas demanded. To more accurately depict these substitutions, each fuel's demand is categorized into distinct sectors, i.e., residential, commercial, industrial, and transportation with its own-price and cross-price elasticity specific to each submarket. Additionally, each fuel is modeled for up to eight components of supply (e.g., for the oil market, supply is modeled from domestic (lower 48) onshore, domestic (lower 48) offshore, Alaska onshore, Alaska offshore, biofuels, other, Rest of World, and Canadian pipeline imports). This complexity allows MarketSim to simulate changes in energy prices and the resulting substitution effects between the various fuels in the presence of changes in OCS oil and gas production. Additional details about how MarketSim models fuel substitutions across energy markets can be found in the MarketSim documentation (Industrial Economics, Inc., 2017).

Table 4-10 shows the substitution of other energy sources as percentages of the Proposed Action's forgone production of oil and gas under the No Action Alternative. For example, the estimated production from the Proposed Action is 246 millions of barrels of oil equivalent (mmBOE). Under the No Action Alternative, MarketSim estimates that 66 percent or approximately 162 mmBOE, would be replaced by imports. Another way to look at this would be to say that 162 mmBOE of imports are estimated to be displaced by anticipated high-case production under the Proposed Action scenario.

5 NEMS projections including production from new OCS leasing is typically reported in EIA's *Annual Energy Outlook* (EIA 2020).

Table 4-10: Substitution of Other Energy Sources Under the No Action Alternative

Substitute Energy Source	% of Proposed Action Forgone Production
Onshore Production	23.2%
Onshore Oil	5.2%
Onshore Gas	18.0%
Production from Existing State/Federal Offshore Leases	0.8%
Imports	66.2%
Oil Imports	65.8%
Gas Imports	0.3%
Coal	0.4%
Electricity from Sources Other Than Coal, Oil, and Natural Gas	0.8%
Other Energy Sources	3.5%
Reduced Demand/Consumption	5.1%

Notes: The percentages in this table represent the percent of forgone production that is replaced by a specific energy source (or in the case of reduced demand/consumption, not replaced) with the selection of the No Action Alternative. They can be interpreted as the percentage of anticipated production that would have been produced from the Proposed Action if leasing had occurred that would be replaced (e.g., 23% by onshore production of oil and natural gas).

The OECM and Upstream GHG Emissions Estimates

BOEM estimates upstream emissions of the Proposed Action and the energy substitutes using the OECM. The OECM takes the E&D scenario estimates of exploration, development, and production activity as well as other outputs from MarketSim to estimate the upstream GHG emissions from the Proposed Action. The model also uses outputs from MarketSim to estimate the upstream emissions associated with the substitute energy sources (e.g., oil imports, onshore gas production) under the No Action Alternative. MarketSim estimates differences in gross energy exports between the No Action Alternative and the Proposed Action. The range of activities and their respective GHG emissions factors assumed by the OECM are available in the OECM documentation.6

The GHG Model: Midstream and Downstream GHG Emissions Estimates

The GHG Model incorporates the upstream emissions from the OECM and the energy substitutions from MarketSim with additional information to generate the lifecycle estimate. The model also includes additional calculations for the emissions associated with the onshore processing (refining and storage), the delivery of energy (i.e., oil, natural gas, or other energy substitutes) to the final consumer, and eventually the consumption of the oil and gas products. The GHG Model also relies on the substitution estimates from MarketSim to estimate mid- and downstream emissions under the No Action Alternative. The GHG Model provides the annual emission estimates for the Proposed Action and No Action Alternative domestic midstream and downstream. More details on the GHG Model are available in the model documentation (Wolvovsky and Anderson, 2016).

Foreign GHG Emissions Methodology

The analysis prepared for LS 258 represents BOEM's first time estimating the change in foreign emissions resulting from a lease sale. Here BOEM attempts to use best available information and convert MarketSim's estimate of the change in global oil market demand between the Proposed Action and the No Action Alternative into a change in GHG emissions. As described in the section "Global Lifecycle Greenhouse Gas Analysis," the foreign energy market simulations using MarketSim are necessarily more simplistic given limited information when compared to that available for the U.S. domestic energy

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6 The OECM estimates emissions from upstream activity: exploration, development, production, and transport to shore of OCS oil and gas. This includes emissions associated with (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. In addition to the Proposed Action, the OECM also calculates the GHG emissions from the production and transport of the energy substitutes anticipated to be produced under the No Action Alternative. See documentation at: OECM Vol 1: https://espis.boem.gov/final%20reports/BOEM_2018-066.pdf and OECM Vol 2: https://espis.boem.gov/final%20reports/BOEM_2018-067.pdf.

markets. However, to comply with the two recent court decisions cited above, BOEM is attempting to quantify the change in foreign emissions resulting from a lease sale. To do so, BOEM has had to make simplifying assumptions that allow for use of a broad foreign oil consumption estimate made by MarketSim and a generic GHG emissions factor published by the EIA to arrive at a reasonable estimate for GHG emissions from foreign oil consumption under the No Action Alternative relative to the Proposed Action. Given that this analysis is the first of its kind for BOEM and offshore oil and gas leasing, BOEM expects to make refinements to its analysis for the Final EIS for LS 258 based on comments received on this draft, and future refinements or decisions regarding its relevance for other upcoming OCS lease sales will be likely in the future.

As described within the MarketSim and Energy Market Substitutions section above, under the No Action Alternative oil prices would be expected to be slightly higher due to the lower energy supply relative to the Proposed Action. Oil is a global commodity meaning any price changes will likely impact global production and consumption. MarketSim estimates changes in foreign oil production and consumption to determine an oil global equilibrium (the price where supply equals demand). MarketSim estimates the change in foreign consumption for each year of anticipated production.

The GHG model takes the annual change in foreign consumption and applies an emissions factor attributable to combusted oil. For this analysis, BOEM uses a single EPA emissions factor called 'Other Oil <401°F'. Normally, rather than using a single emissions factor, a range of emissions factors would be used that corresponds to the different end use of petroleum products after oil refining. However, BOEM has applied a single emissions factor to all combusted oil, due to a lack of information about the end petroleum products consumed in foreign markets. The GHG Model's ability to account for non-combustion uses of oil was applied based on the U.S. market, as an approximation (Wolvovsky and Anderson, 2016).

Domestic Production and Consumption Lifecycle Greenhouse Gas Analysis

Table 4-11 shows the estimates of lifecycle GHG emissions of domestically consumed or produced energy for both the Proposed Action and the No Action Alternative. BOEM determined that the other action alternatives, which exclude certain lease blocks, will not increase the total level of activity considered under the high activity case E&D Scenario. While these alternatives would focus activities away from certain areas or prohibit activities during certain times of the year, the overall lifespan of the lease sale activities would be similar and not vary significantly for air emissions, including GHG emissions from direct emissions, transportation, or lifecycle emissions from combustion of resources. Thus, the downstream lifecycle of CO_2e emissions for all action alternatives will be similar to those for the Proposed Action.

BOEM estimates about 9.3 million metric tons of CO_2e will be emitted due to the Proposed Action from upstream activities and 79.0 million metric tons of CO_2e will be emitted from mid- and downstream activities associated with the Proposed Action.

BOEM further calculates that under the No Action Alternative, in the absence of the LS 258 production, oil prices will be slightly higher than they would be under the Proposed Action. The average differences in price in the No Action Alternative relative to the Proposed Action over the 32 years of oil and natural gas production anticipated from LS 258 are: $0.013/Bbl higher for oil; $0.00059/mcf higher for natural gas; $0.00034/ton higher for coal; and $0.0009/kWh higher for electricity. With those higher oil and natural gas prices, MarketSim estimates that energy demand (from all modeled energy sources) will be approximately 12.56 mmBOE lower in the No Action Alternative compared to the Proposed Action (roughly 5 percent of the 246 mmBOE anticipated from LS 258). Specifically, for oil, MarketSim estimates U.S. demand to be 8.13 mmBOE less under the No Action Alternative. While oil and natural gas demand are lower in the No Action Alternative, there is higher onshore production (largely natural gas) and imports (largely oil) in addition to higher coal and electricity consumption and production.

BOEM estimates that these substitute energy sources emit about 11.1 million metric tons of CO_2e from upstream activities and 73.9 million metric tons of CO_2e from mid- and downstream activities. The No Action Alternative results in more CO_2e for upstream activities than the Proposed Action given that collectively the substitute energy sources have higher GHG emissions per unit of production than the forgone domestically produced OCS oil and natural gas of the Proposed Action. However, the Proposed Action results in higher midstream and downstream emissions than the No Action Alternative given the slightly lower consumption and the fuel switching away from oil. In net, BOEM's modeling shows that emissions from domestic production and consumption from the No Action Alternative will be 3.4 million metric tons of CO_2e less than the Proposed Action.

Table 4-11: Domestic Production and Consumption Lifecycle GHG Emissions

	Upstream				Midstream and Downstream				Lifecycle			
	CO_2e	CO_2	CH_4	N_2O*	CO_2e	CO_2	CH_4	N_2O*	CO_2e	CO_2	CH_4	N_2O*
	Thousands of Metric Tons											
No Action (A)	11,105	8,517	102	*	73,859	73,157	22	1	84,963	81,674	124	1
Proposed Action (B)	9,347	7,709	63	*	79,032	78,256	24	1	88,378	85,965	87	1
Difference (A-B)	1,758	808	39	*	(5,173)	(5,099)	(3)	*	(3,415)	(4,291)	36	*

Notes: Values rounded to nearest 1,000 metric tons.
* Values are between -0.5 and 0.5.

Foreign Lifecycle Greenhouse Gas Analysis

MarketSim estimates that under the No Action Alternative, foreign oil consumption would be roughly 86.4 MMbbl lower than the Proposed Action in total over the 32-year production period estimated for the Proposed Action. This difference represents 0.0064 percent of the global consumption of 1.3 trillion barrels under the No Action Alternative during this time period. Table 4-12 presents the reduction in GHG emissions attributable to the lower foreign consumption of oil under the No Action Alternative.[7] Foreign oil consumption estimated under the No Action Alternative emits 31.4 million metric tons of CO_2e less GHG emissions compared to foreign consumption estimated under the Proposed Action.

Table 4-12: GHG Emissions from Shift in Foreign Consumption Under the No Action Alternative (when compared to the Proposed Action)

	Foreign Downstream Emissions (Crude Oil and Petroleum Product Consumption Only)			
	CO_2e	CO_2	CH_4	N_2O
	Thousands of Metric Tons			
No Action	(31,355)	(31,247)	(1)	*

Notes: Values rounded to nearest thousand metric tons. Negative values represent the lower foreign downstream emissions under the No Action Alternative relative to the increased foreign emissions under the Proposed Action.
* Values are between -0.5 and 0.5 thousand metric tons.

The lower global oil consumption associated with the No Action Alternative has been quantitatively analyzed for other oil infrastructure projects, such as the Keystone XL pipeline (Erickson and Lazarus, 2014) and BOEM's 2017–2022 National OCS Oil and Gas Leasing Program (Erickson, 2016). Both analyses reflect lower GHG emissions from global oil consumption under a no action alternative, when compared to the proposed actions under consideration. Both analyses used a multiplier to quantify GHG emissions resulting from increases in global oil consumption. BOEM agrees with the primary contention of both papers (cited above) that a reduction in domestic production leads to less foreign consumption and subsequently lower foreign emissions. Central to the authors' argument is their calculation that a change

7 While these could alternatively be presented as an increase of GHG emissions under the Proposed Action, it is more consistent with BOEM's substitution analysis to present it under the No Action Alternative as a reduction in emissions.

(‘Δ’) in foreign consumption can be estimated by multiplying the change (‘Δ’) in imports consumed in the U.S. by a ratio (‘factor’) of the foreign elasticities of demand (E_d) and supply (E_s):

$$\Delta\, Foreign\ Consumption \cong \Delta\, Forgone\ U.S. Imports\ Available\ to\ Foreign\ Markets * \frac{E_d}{(E_d - E_s)}$$

BOEM finds that its results (using MarketSim) closely align with this calculation, though the elasticity assumptions used by BOEM here differ from the authors cited above. BOEM’s MarketSim currently has an elasticity of foreign demand (E_d) of -0.45 and an elasticity of foreign supply (E_s) of 0.4, resulting in a factor equal to 0.53. BOEM’s MarketSim estimates that U.S. oil imports decrease by 161 MMbbl due to the Proposed Action. Erickson’s equation treats these forgone U.S. imports as equivalent to new production which is available to foreign markets and is used to calculate the increase in foreign consumption from the Proposed Action. Using Erickson’s (2016) methodology, the 0.53 factor and estimated forgone oil imports of 161 MMbbl yields a change (increase) in foreign oil consumption of 85.3 MMbbl. This result is very similar to BOEM’s estimation that foreign consumption would increase by 86.4 MMbbl over the entire 32 years of production estimated under the Proposed Action. BOEM is continually seeking to update its models as new information and methodologies become available. BOEM is currently working with its contractor to update MarketSim and its underlying elasticity assumptions. BOEM intends to use this model and the relevant updates, if available, for the Final EIS analysis of GHG emissions and Social Cost of Greenhouse Gases (SC-GHG). Additional information on this analysis and its limitations is included in section *Global Lifecycle Greenhouse Gas Analysis*.

4.3.5.2 Monetized Impacts from GHG Emissions

The “Social Cost of Carbon” (SCC), “social cost of nitrous oxide” (SCN), and “social cost of methane” (SCM) – together, the “social cost of greenhouse gases” (SC-GHG) – are estimates of the monetized damages associated with incremental increases in GHG emissions in a given year.

On January 20, 2021, President Biden issued E.O. 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis.[8] Section 1 of E.O. 13990 establishes an Administration policy to, among other things, listen to the science; improve public health and protect our environment; ensure access to clean air and water; reduce greenhouse gas emissions; and bolster resilience to the impacts of climate change.[9] Section 2 of the E.O. calls for Federal agencies to review existing regulations and policies issued between January 20, 2017, and January 20, 2021, for consistency with the policy articulated in the E.O. and to take appropriate action.

Consistent with E.O. 13990, the CEQ rescinded its 2019 “Draft National Environmental Policy Act Guidance on Considering Greenhouse Gas Emissions” and has begun its review for updating its “Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews” issued on August 5, 2016 (2016 GHG Guidance).[10] While CEQ works on updated guidance, it has instructed agencies to consider and use all tools and resources available to them in assessing GHG emissions and climate change effects including the 2016 GHG Guidance.[11]

Regarding the use of SCC or other monetized costs and benefits of GHGs, the 2016 GHG Guidance noted that NEPA does not require monetizing costs and benefits.[12] It also noted that “the weighing of the merits and drawbacks of the various alternatives need not be displayed using a monetary cost-benefit analysis and should not be when there are important qualitative considerations.”[13]

8 86 FR 7037 (Jan. 25, 2021).
9 *Id*., Sec. 1.
10 86 FR 10252 (February 19, 2021).
11 *Id.*
12 2016 GHG Guidance, p. 32, available at: https://ceq.doe.gov/docs/ceq-regulations-and-guidance/nepa_final_ghg_guidance.pdf
13 *Id*.

Section 5 of E.O. 13990 emphasized how important it is for federal agencies to "capture the full costs of greenhouse gas emissions as accurately as possible, including by taking global damages into account" and established an Interagency Working Group on the Social Cost of Greenhouse Gases (the "IWG")14). In February of 2021, the IWG published the Technical Support Document *Social Cost of Carbon, Methane, and Nitrous Oxide: Interim Estimates* under Executive Order 13990 (IWG, 2021).15 This is an interim report that updated previous guidance from 2016. The final report is expected in January 2022.

In accordance with this direction, this section (4.3.5) provides estimates of the monetary value of changes in GHG emissions that could result from selecting the No Action or Proposed Action Alternatives. Such analysis should not be construed to mean a cost determination is necessary to address potential impacts of GHGs associated with specific alternatives. These numbers were monetized and annualized; however, they do not constitute a complete cost-benefit analysis, nor do the SC-GHG numbers present a direct comparison with other impacts analyzed in this Draft EIS. For instance, BOEM's overall analysis for Cook Inlet LS 258 does not monetize most of the major costs or benefits and does not include all revenue streams from the proposed lease sale but seeks to quantify certain impacts related to employment numbers and labor income. SC-GHG is provided only as a useful measure of the benefits of GHG emissions reductions to inform agency decision-making.

Uncertainty in Computing Social Costs

The IWG provides impact estimates evaluated at three different discount rates (5 percent, 3 percent, and 2.5 percent). The IWG includes the 5 percent, 3 percent, and 2.5 percent discount rate at the average level of damage, but also includes a fourth case at the 3 percent discount rate and the 95th percentile of damages.[16]

The different discount rates and their assumption of a statistical level of damages represent uncertainty within SC-GHG estimates. With higher discount rates, future damages are more discounted and less significant in the total estimated costs. Because damages from GHG emissions are long-term, higher discount rates lead to lower estimates of the SC-GHG. This is evident when comparing the SC-GHG at a 2.5 percent discount rate versus 5 percent discount rate, both at average statistical damages.

The assumption of a statistical level of damages plays a significant role in capturing uncertainty. The IWG interim report contains frequency distributions that show uncertainty in the quantified parameters defining the damage functions of the three models (DICE, PAGE, FUND) used to estimate the sets of SC-GHG values. The magnitude of uncertainty reflected in the distribution of damages is evident by comparing the average and 95th percentile values of the 3 percent discount rate models. There are additional sources of uncertainty that are not quantified in these estimates. For example, the damages associated with ocean acidification are not included in any of the three climate models. Uncertainty around those impacts is thus not captured within the SC-GHG but may be captured qualitatively within this Draft EIS. For example, ocean acidification is discussed throughout (see Section 4.4.4; Cumulative Effects).

Methodology for Estimating the Social Cost of Greenhouse Gas Emissions

The SC-GHG represents the monetary value of the net harm to society associated with adding one metric ton of GHG to the atmosphere in any given year. A SC-GHG value is specific to a given year and increases through time as the harm in later years leads to greater damages given the compounding nature

14 E.O. 13990, Sec. 5.

15 https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

16 The models used to assess damages from an additional metric ton of GHG perform tens of thousands of simulations as to how that metric ton of emissions would work its way through the underlying assumptions of the model to arrive at a distribution of probable damages, based on one estimate for each of those tens of thousands of runs. The SC-GHG at the 95th percentile suggests that 95 percent of the simulations are at or below the SC-GHG estimate. The average statistical values suggest that they are the average of all values simulated.

of GHG emissions and their relationship to an increasing Gross Domestic Product (GDP).[17] The SC-GHG emissions represent the value of the future stream of damages associated with a given metric ton of emissions discounted to the year of emission.

BOEM uses the IWG's annual SC-GHG estimates for each of the three GHGs to compute the Proposed Action and No Action Alternative social cost estimates. The total SC-GHG is then discounted back to a net present value (NPV) using the same discount rate as the IWG's SC-GHG. Next, the NPV for the three GHGs are aggregated to derive the total SC-GHG for the Proposed Action and No Action Alternative under the specific discount rate and statistical damage assumptions for that set of SC-GHG values. BOEM provides an estimate for each of these cases.

A detailed example of the calculation is provided below.

1. The IWG provides SC-GHG estimates through 2050. BOEM extrapolated for future years using the growth rate for the final 5 years available using the equation:

$$\left(\frac{2050\, SC - GHG\ \ value}{2045\, SC - GHG\ \ value}\right)^{\frac{1}{5}}$$

2. The IWG presents the SC-GHG estimates in 2020 dollars. BOEM has inflated these social cost estimates to 2022 dollars based on the assumed start date of the Proposed Action.[18] Table 4-13 provides examples of the IWG SC-GHG values at the 3 percent discount rate and average statistical damages assumption inflated to 2022 dollars for the first year of GHG upstream emissions (2024), the peak year of upstream GHG emissions (2040), and the last year of upstream GHG emissions (2060).
3. The inflated annual IWG estimates of SC-GHG are applied to the annual emissions estimate for each of the three gases. Table 4-13 shows the upstream emission estimates for the Proposed Action. Note that the first and last year do not have methane (CH_4) and nitrous oxide (N_2O) emissions because those are not associated with the activities taking place in those years.

Table 4-13: Example of Proposed Action's Domestic Upstream GHG Emissions in Select Years

	IWG's SC-GHG Estimates			GHG Emissions			Social Cost of GHG Emissions		
	Methane (CH_4)	Carbon dioxide (CO_2)	Nitrous oxide (N_2O)	Methane (CH_4)	Carbon dioxide (CO_2)	Nitrous oxide (N_2O)	Methane (CH_4)	Carbon dioxide (CO_2)	Nitrous oxide (N_2O)
Year	2022 $/Metric Ton (at 3% discount rate, average damages)			Million Metric Tons			2022 $		
2024	1,711	57	20,616	-	14.45	-		0.82	
2040	2,566	75	28,331	2.70	361.01	0.01	6.94	27.03	0.26
2060	3,799	100	39,891	-	12.62	-		1.26	

4. The above calculation is performed for every year of GHG emission. The annual amounts are then discounted back to the year of analysis (which is 2022 for this project) using the same discount rate used by the IWG for the SC-GHG estimate (in this example, 3 percent).

17 The tables of estimated annual SC-GHG values can be found in the IWG interim report at: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf
18 Inflated using the GDP Chain-type Price Index from EIA's Annual Energy Outlook 2021. Available online at: https://www.eia.gov/outlooks/aeo/tables_ref.php

5. The NPVs for each of the GHGs are aggregated to arrive at an estimated social cost for each discount rate and statistical damage assumption recommended by the IWG. This process is repeated for every component of the lifecycle of the project.

Social Cost of Greenhouse Gas Results: Domestic Production and Consumption Lifecycle

BOEM presents the results of its SC-GHG analysis separately – one for the SC-GHG resulting from domestic production, production of imports, and domestic consumption, and another for those resulting from foreign consumption. Using the methodology described above, Table 4-14 estimates the social cost of the emissions expected from domestic production and consumption in the lifecycle analysis of LS 258 (for the No Action and Proposed Action Alternatives, respectively). Under each of the SC-GHG cases, the social costs of emissions are higher under the Proposed Action than the No Action Alternative.

Table 4-14: Domestic Production and Consumption Lifecycle Social Cost of Greenhouse Gas Emissions

Cook Inlet: Lease Sale 258 – High Activity Level		
2022 $ (Billions)		
No Action SC-GHG (A)	Proposed Action SC-GHG (B)	Difference (A-B)
5% Discount Rate, Average Statistical Damages		
0.93	0.95	(0.02)
3% Discount Rate, Average Statistical Damages		
3.74	3.85	(0.11)
2.5% Discount Rate, Average Statistical Damages		
5.72	5.91	(0.19)
3% Discount Rate, 95th Percentile Statistical Damages		
11.35	11.71	(0.36)

Notes: Values rounded to nearest $10 million. A positive value is a cost. A negative value is a benefit. Incremental SC-GHG is in terms of the No Action Alternative. So, a negative value represents a benefit (lower SC-GHG) under the No Action Alternative.

Social Cost of Greenhouse Gas Results: Foreign Oil Consumption

BOEM followed the same process described above to calculate the social cost of emissions from the lower foreign consumption under the No Action Alternative. Table 4-15 shows the lower cost (i.e., benefits) of the No Action Alternative due to lower global consumption emissions.

Table 4-15: Social Cost of Greenhouse Gas Emissions for Foreign Consumption

Cook Inlet: Lease Sale 258 – High Activity Case		
2022 Billions $		
Discount Rate	Damages Statistic	SC-GHG
5.0%	Average	(0.30)
3.0%	Average	(1.28)
2.5%	Average	(1.99)
3.0%	95th Percentile	(3.93)

Notes: Values rounded to nearest $10 million. Values are presented as negative costs (benefits) as they represent the lower SC-GHG of emissions from lower foreign consumption under the No Action Alternative relative to the Proposed Action.

Global Lifecycle Greenhouse Gas Analysis

Below, BOEM provides a qualitative discussion of the portions of the global lifecycle emissions which BOEM does not quantitatively address. For some of these emissions, BOEM is not able to quantify given data limitations. For other emissions, BOEM is in the process of developing methods to quantify. The foreign GHG emissions estimate and social cost estimates (Table 4-14 and Table 4-15) are only based on changes in foreign oil consumption and are not as comprehensive as the domestic production and consumption lifecycle emissions and social costs for the reasons described above (Table 4-11 and Table 4-12).

With the No Action Alternative, oil prices are higher, foreign oil consumption is lower, and foreign oil production is higher. BOEM's quantitative analysis accounts for the emissions associated with the relatively lower oil consumption.

The price impacts under the No Action Alternative also affect other global energy markets (e.g., natural gas, coal). The same substitutions discussed earlier also occur in the foreign markets. BOEM's quantitative analysis does not consider any emissions impacts associated with production or consumption of these other fuels because of the relative complexity of such calculations and the limited value such calculations would provide.

For the foreign upstream market, BOEM estimates that crude oil production in foreign markets would be higher under the No Action Alternative than it would be for the Proposed Action. Upstream GHG emissions resulting from this higher foreign oil production in the No Action Alternative are currently not quantified, due to lack of sufficient data regarding where the production occurs and appropriate emissions factors to apply to that production. However, BOEM is evaluating a methodology that may allow for quantifying this estimated change in foreign oil production. In the interim, available information suggests the changes in foreign oil production would increase the GHG emissions under the No Action Alternative and potentially mitigate (decrease) some of the increased GHG emissions under the Proposed Action. However, even when combined with other potentially offsetting sources of emissions from foreign energy substitutes currently not quantified under the No Action Alternative, the mitigating changes in foreign oil production would not overcome the full magnitude of increased GHG emissions under the Proposed Action (i.e., the Proposed Action would still result in increased GHG emissions when compared to the No Action Alternative).

For the domestic production and consumption analysis, MarketSim and the GHG model estimate the emissions associated with the production of energy substitutes (e.g., foreign oil which is imported to the U.S. in the No Action Alternative). However, the foreign GHG emissions quantitative analysis is limited to the foreign downstream (consumption) of oil only. Missing from the foreign emissions impacts are changes in the upstream and midstream emissions associated with the downstream consumption. Moreover, while foreign oil consumption decreases in the No Action Alternative, foreign energy substitutes will also likely increase (e.g., because oil prices are relatively higher, consumption of oil will be lower but there will also be some fuel switching to other fuels, for example coal). Because the foreign analysis is not comprehensive, the domestic production and consumption emissions and social costs are not directly comparable to the foreign estimates. Thus, BOEM is not providing a combined estimate of domestic and foreign emissions because it is inappropriate to add them together.

While BOEM is investigating methods to incorporate the global upstream emissions, estimating the full lifecycle of the foreign energy substitutes other than oil is more complex and, as discussed above, the results would not change the conclusion of the analysis here. The inputs for BOEM's domestic GHG model are illustrative of the range and depth of data necessary to credibly conduct a full quantitative analysis of changes in foreign GHG emissions. BOEM's MarketSim model adopts assumptions from the EIA—the primary federal government authority on energy statistics and analysis—and from economics literature cited in the model documentation. These assumptions help BOEM estimate where substitute sources of oil and gas would come from (i.e., oil and gas production from state submerged lands, onshore domestic production, international imports) and the other types of energy sources that would be utilized to help energy supplies keep pace with demand (i.e., coal, biofuels, nuclear, renewable energy). Accurately estimating this mix of substitute energy sources is important because each substitute energy source entails a different capacity to produce lifecycle GHG emissions over the course of its production, transportation, refining, and/or consumption.

A main factor in considering the impact of the change in foreign oil consumption is identifying the other energy sources which have been replaced with oil consumption, given the price reduction. The sources can vary throughout the world. In some areas, the oil may replace coal. In these areas the emissions associated with the oil consumption increase may bring a reduction in global emissions as a result of the Proposed Action. However, it is unlikely that coal would substitute for oil on such a scale as to fully compensate for the decrease in emissions from lower foreign oil consumption under the No Action Alternative relative to the Proposed Action. Alternatively, other areas may rely more heavily on natural gas, biofuels, nuclear, or renewable energy, all of which have a lower GHG intensity than oil. In these cases, the shift to oil leads to a net increase in emissions though the net change in emissions would still not be as large as that estimated in Table 4-12. While the degree to which various energy substitutes might replace forgone oil consumption in foreign energy markets under the No Action Alternative is uncertain, it is appropriate to acknowledge that substitution would certainly occur and mitigate a portion of the decreased emissions due to forgone foreign oil consumption.

4.3.5.3 GHG Analysis and SC-GHG Summary

Considering only the domestic production and consumption through the GHG lifecycle analysis, BOEM finds in this LS 258 analysis that the No Action Alternative will result in fewer GHG emissions than the Proposed Action. Further, when adding the impact of changes in foreign oil consumption under the No Action Alternative, the reduction is even larger when compared to the Proposed Action. While BOEM's analysis does for the first time include quantification of foreign consumption, the analysis cannot include quantification of upstream or foreign substitutes emissions at this time. However, such estimates would not be expected to change the results of BOEM's analysis as BOEM expects the end result of fewer GHG emissions in the No Action Alternative to remain. BOEM's GHG quantitative and qualitative analyses together represent the best available approach for comparison of GHG emissions from the Proposed Action and the No Action Alternative and serve as a proxy for evaluating and comparing impacts to climate change under the Proposed Action and No Action Alternative.

Nonetheless, BOEM continues its review and study of these issues and will update the foreign lifecycle analysis as new data and methodologies become available. BOEM has included the global analysis in this document as an initial analysis and seeks public comment to refine it for use in evaluating LS 258 and potentially for other OCS oil and gas lease sales in the future if it is deemed useful.

4.4 Water Quality

4.4.1 Affected Environment

Cook Inlet is a complex estuary receiving freshwater discharge from numerous rivers and streams and marine connections with Shelikof Strait and the Gulf of Alaska. Water, hosting a large variety of naturally occurring inorganic and organic compounds, is transported into Cook Inlet by streams, rivers, point and non-point source wastewater discharges, groundwater, atmospheric deposition, runoff, and currents from the Gulf of Alaska. Suspended or dissolved substances within the water column are rapidly dispersed by the highly dynamic tidal and subtidal currents.

Many of the streams flowing into Cook Inlet are glacially fed and contain high concentrations of suspended particulate matter (Segar, 1995). Seasonally, an estimated 99 percent of the annual suspended particulate matter is carried by rivers and streams from May through October during spring and storm events (Okkonen et al., 2009; Parks and Madison, 1985). Concentrations of TSS fluctuate daily due to tidal cycles and riverine inputs. They are higher in the most northern stream-influenced end of the upper inlet and decrease through lower Cook Inlet (Feely and Massoth, 1982; Saupe et al., 2005; Segar, 1995). In upper Cook Inlet, suspended sediment concentrations are typically high and can reach 2,000 parts per million (ppm), and measurements of light transmittance yield values <10 percent (Saupe et al., 2005). In lower Cook Inlet, suspended sediment concentrations are more typically <100 ppm (Saupe et al., 2005; Segar, 1995) and light transmittance values approach 100 percent. Overall, about 80 to 90 percent 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 primarily from the Knik, Matanuska, and Susitna rivers (MMS, 2001; Feely and Massoth, 1982; Trefry, 2000).

The quality of water in the Cook Inlet Planning Area meets criteria for the protection of marine life according to Section 403 of the Clean Water Act (CWA). No waterbodies directly draining into the Proposed Action area are identified by the State of Alaska as impaired per Section 303 of the CWA (ADEC, 2018). While contaminants have been reported, many are attributed to erosion of the local soils, rocks and ores, and few can be decidedly linked to human activities unlike anthropogenic input of pollutants at urban centers that have deleteriously impacted local streams and lakes (e.g., Chester Creek; Brabets and Whitman, 2004; Glass et al., 2004). Furthermore, in 2005 water quality data collected at approximately 20 locations in Cook Inlet met Alaska Water Quality Standards (AWQS) criteria for all marine water uses (Saupe et al., 2005). Hydrocarbon concentrations in Cook Inlet sediments are comparable to values reported for background hydrocarbons in Alaska offshore coastal waters; therefore, oil and gas production in upper Cook Inlet does not appear to be a source of petroleum contaminants (Boehm, 2001).

Previous studies have found no indication of heavy metal pollution in lower Cook Inlet but some evidence of elevated mercury (Hg) in suspended sediment, most likely linked to riverine inputs, may originate naturally or from past mining and other anthropogenic activities (Kinnetic Laboratories, 2010; Segar, 1995). Kinnetic Laboratories (2010) found dissolved metal concentrations from Cook Inlet to be less than the AWQS and no evidence for enhancement of any metal concentrations in bottom sediments could be linked to discharges of produced water from oil and gas activities. Metal concentrations of Ba, Cd, Cr, Cu, Ni, Pb and Zn [19] for bottom sediments were reported at background levels for all 55 stations sampled throughout Cook Inlet (Kinnetic Laboratories, 2010). Similarly, 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. Elevated levels of arsenic (As), Cu, and Ni, and variations in concentrations between the locations were attributed to differences in local geology and large coal deposits in the region.

4.4.2 Environmental Consequences of the Proposed Action

4.4.2.1 Discharges

Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, which disturb the seafloor generate a resuspension of sediment or discharge directly to the water which could impact water quality through introduction of suspended solids, turbidity, and other pollutants. Such activities include drilling of exploration, delineation, production, and service wells; anchoring; installing and removing nodes, cables, and sensors; trenching activities for subsea/shoreline pipelines; preparation of the seabed for exploration and/or production platforms; and pipe decommissioning.

Total Suspended Solids, Turbidity, Metals, and other Pollutants

Turbidity, and its associated TSS in the water column would be temporarily and locally increased from seafloor disturbance activities decreasing over time as suspended solids settle to the ocean floor. Resuspended sand would settle rapidly from the water column, while finer-grained materials would travel further before settling to the seafloor; settling rates and the strength of the ambient currents would determine the transport distances of the finer-grained sediment. Elevated TSS levels from temporary seafloor disturbance activities are highly unlikely to exceed ambient TSS levels that naturally occur from riverine and stream inputs draining into Cook Inlet (Saupe et al., 2005). Strong and fast tidal currents characteristic of Cook Inlet would rapidly disperse and resettle additional suspended sediment with natural, ambient water quality conditions expected after operations cease.

19 Ba (Barium), Cd (Cadmium), Cr (Chromium), Cu (Copper), Ni (Nickel), Pb (Lead), and Zn (Zinc).

Seafloor disturbance and an increase in TSS (as described above), metals, and other pollutants would be expected with the discharge of approximately 5,000 cubic yards (cy) of rock cuttings and 72,000 bbls of drilling fluids from exploration and delineation well drilling (Section 4.1, Table 4-1). Drill cuttings and fluids discharged into the marine environment disperse in the water column increasing turbidity, accumulate on the seafloor potentially smothering benthic organisms, elevate concentration of some trace metals, and alter sediment characteristics (NRC, 1983, 2003, 2005). Regulated by the EPA as a point-source discharge through the NPDES permitting program, drilling discharges must not cause unreasonable degradation of the marine environment (EPA, 2015b). BOEM expects that all discharges from lease activities associated with LS 258 would comply with permit limits set forth by the NPDES program.

Some commercially available drilling fluids contain elevated concentrations of several trace metals and, if bioavailable (absorbed and utilized by a living system), can harm the local marine ecosystem (Neff, 2008). Barite, a mineral used in water-based drilling fluids, contains the trace metals Ba and Cr in concentrations above what is typically found in marine sediments (Melton et al., 2000; Neff, 1988). Other metals associated with barite can include Cu, Ni, Pb, and Zn, and hydrocarbons are also introduced to the environment with the discharge of drilling fluids (Breuer et al., 2004; Neff, 2008). Metals associated with the solid barite particles present in the drilling fluids plume suspended in the water column and in the rock cuttings pile on the seafloor are not bioavailable (Neff, 2008). Metals in solution in the sediment porewater (the water that fills the pores between the grains of sediment) or in the drilling fluids plume are more bioavailable and toxic than the solid, particulate metals (Simpson and Batley, 2007). For metals to cause harm to the aquatic ecosystem, they must be both bioavailable and of high enough concentrations to be potentially toxic (Neff, 2008). Results of almost four decades of field and modeling studies suggest that dissolved compounds and particulate matter from water-based drilling fluids are rapidly diluted (Neff, 2010). In the high-energy environments of Cook Inlet, little of the rock cuttings and fluids associated with drilling would be expected to accumulate near well sites because deposits are quickly transported away by strong currents (Hannah and Drozdowski, 2005). Consequently, drilling solids and fluids would be dispersed over large areas in low concentrations depending upon the hydrodynamics near to discharge (Neff, 2010). In areas lacking strong bottom currents, drill cuttings are typically concentrated within 500–1,000 m (820–1,640 ft) of the seafloor discharge location (Continental Shelf Associates, 2006; Neff, 1988, 2010), with the majority of drill cuttings deposited within 100 m (328 ft) (EPA, 2015a). The total seafloor area affected by exploration drilling discharges would depend on the number of wells drilled and local hydrodynamics. The temporary, short-term discharge of exploration and delineation rock cuttings and fluids coupled with rapid dilution with little to no seafloor accumulation of rock cuttings and fluids, would result in localized and short-term impacts to water quality.

Temperature and salinity are also considered pollutants and drilling fluids are typically warmer and more saline than marine waters. Localized and temporary increases in temperature and salinity would immediately be attenuated in the marine environment as drilling fluids are mixed with ambient seawater, with little to no impacts to water quality.

Other Discharges

An NPDES permit must be obtained from the EPA for all oil and gas operational discharges (including vessel discharges), during exploration, production, and decommissioning. Aside from exploration cuttings and fluids discussed above, discharges such as bilge water, ballast water, fire control system test water, cooling water, sanitary and domestic wastes, and deck drainage could contain a variety of nutrients, trace metals, and other pollutants. While these pollutants have the potential to impact water quality near the point of discharge, these discharges are expected to represent only small pollutant loadings when properly designed and functioning equipment is used, and little to no impacts would be expected. Production and development cuttings and fluids would not be discharged, but are assumed to be reused, reinjected, or barged to shore for onshore disposal (see Section 4.1.2 for E&D Scenario production and development assumptions); subsequently, no impacts to the marine environment would result from these specific discharges.

4.4.2.2 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on water quality are described in Section A-3.2 of Appendix A. Most accidental spills would be small and have relatively inconsequential impacts to water quality. Localized and short-term impacts to water quality could occur as a result of spill drill activities such as surf washing, shoreline flushing, in-situ burning and application of dispersants (see Section A-3.2.3 of Appendix A). A large oil spill would impact water quality in the area of the release and if the spill occurred under broken ice, it might have long-lasting, albeit localized, impacts. Long-term impacts could result should the spill reach the shoreline affecting estuarine and riverine waters. Spill response and cleanup activities could degrade water quality in the immediate area resulting from any flooding, washing, flushing, or other mechanical activities during the removal of shoreline contamination. A large gas release would temporarily displace oxygen in the water column, but this impact would be brief because gas migrates upward and ultimately dissipates into the atmosphere.

4.4.2.3 Conclusion

Post-lease activities, as described in the E&D Scenario, accidental spills, and spill drills would result in impacts to marine and estuarine water quality. The increase in TSS from construction activities would cause temporary impacts to water quality during, and for a short duration following, the construction period. Discharge of exploration and delineation well rock cuttings and fluids and other operational discharges would have short-term and localized impacts on the overall water quality. The overall impact of elevated TSS levels along with impacts from small spills and spill drills to water quality would be minor over the life of LS 258 exploration and development, as described in the E&D Scenario, and would not result in any long-lasting change to water quality nor its function in the ecosystem. The addition of a large oil spill and any ensuing spill response would increase the overall impact on water quality to moderate because the effects could be long-lasting and widespread. Hydrocarbon contamination could persist in sediments or ice and be reintroduced into the water column by weather, storm events, or tidal currents. Long-term persistence of hydrocarbon contamination in marine or shoreline sediments could continue for decades, particularly in remote locations.

4.4.3 Environmental Consequences of the Alternatives

Potential impacts on water quality under all action alternatives would not differ substantially from those described for the Proposed Action. These alternatives would not change the total level of activity considered in the E&D Scenario, and none of the restrictions identified in these alternatives would be expected to change the likelihood or severity of impacts on water quality. Consequently, impacts of these alternatives on water quality would be the same as those for the Proposed Action – minor over the life of the E&D Scenario, accidental small spills, and spill drills. The addition of a large oil spill and any ensuing spill response would increase the overall impact on water quality to moderate because the effects could be long-lasting and widespread.

4.4.4 Cumulative Effects

Past, present, and RFFAs that could cumulatively impact the water quality of Cook Inlet and fresh or estuarine waters on surrounding lands include oil and gas operations, mining, marine transportation, ports and terminals, vessel traffic, and oil spills. Climate change is considered another source of cumulative effects on water quality. Potential impacts to water quality could result from increases in TSS, turbidity, and pollutants; increases in vessel discharges; an increased occurrence of large hydrocarbon spills; and climate change.

Localized and intermittent increase of TSS, turbidity, and pollutants directly into the water column resulting from routine and operational discharges during the exploration, production, and decommissioning stages of offshore oil and gas activities have occurred in the past and would be expected to occur for present and RFFAs. The types of cumulative impacts from these activities would be the same as those described in Section 4.4.2. Resuspension of seafloor sediments and the introduction of suspended solids into the water column from discharges and seafloor disturbances resulting from pipeline installation and placement of anchors, nodes, cables, and sensors would create temporary localized sediment plumes.

Vessel activity in support of these activities would also diminish water quality on a seasonal and localized level. Although an increase in turbidity, TSS, and pollutants from these RFFAs would be expected, the mandatory permitting requirements set forth by EPA's Vessel General Permit and the U.S. Coast Guard's (USCG) ballast water management regulations (33 CFR 151(D)) minimize and mitigate these discharges serving to assure that little to no impact occurs to the aquatic ecosystem.

Large oil spills have the greatest potential of all oil- and gas-related activities to affect water quality. The introduction of hydrocarbons into the water column in a dissolved, emulsion, and/or particulate phase would result in immediate exceedances of physical, chemical, human health, and aquatic life water quality criteria, and may result in acute or chronic effects to marine life. Appendix A also considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. The magnitude of impact to water and sediment quality could be long-lasting, and widespread, depending upon the timing, location, environmental conditions, and other factors surrounding the release event(s).

Long-term and widespread impacts from the warming trend of climate change affecting the North Pacific Ocean (including Cook Inlet's marine and freshwater environments), include ocean acidification, rising sea levels, shoreline erosion, warming of surface water temperatures, and an overall drying of onshore surface waters. Ocean acidification has the potential to alter marine chemistry both by lowering the pH of the surface ocean and the saturation states of biologically important calcium carbonate ($CaCO_3$) (Cross et al., 2018). This reduction in calcium carbonate saturation state has direct impacts on marine life and threatens to fundamentally impact the marine ecosystem. Projections for the open ocean particularly at high latitudes could reach low calcium carbonate levels where dissolution of biogenic carbonate minerals preventing shell and skeleton formation in aquatic organisms occurs by the end of the century (Feely et al., 2009). Highlighting the vulnerability of Alaska's higher latitude marine waters, the global biogeochemical models have suggested that surface water corrosivity resulting from ocean acidification in the Chukchi and Beaufort seas will exceed the range of natural variability within the next 10–15 years (Mathis et al., 2015). Cook Inlet could also experience higher corrosivity levels, potentially impacting calcifying organisms such as clams, mollusks, and other organisms. Ocean acidification is projected to have negative effects on many species and the biological response to ocean acidification will be determined by the frequency, magnitude, and duration of variability in carbonate chemistry that result in conditions crossing important thresholds for specific biological organisms and life states (Mathis and Cross, 2014).

Mandatory water quality criteria require that state and federal permitted discharges, specifically those with limits on pH, temperature and salinity, meet standards even as background pH levels potentially decrease over the 40-year E&D Scenario timeframe. Acidified, corrosive areas would impact offshore and onshore operations by driving new permit limits, particularly for these parameters. More stringent requirements for permit limitations would be imposed to mitigate against localized ocean acidification hot spots with the long-term goal of maintaining water quality suitable for aquatic life and human health. Should ocean acidification in nearshore waters reach threshold levels that would impact aquatic life, the State of Alaska would be obligated to list the Cook Inlet as an impaired waterbody in accordance with Section 303(d) of the CWA's listing requirements. This designation would in turn affect all point and non-point source discharges.

Overall, the cumulative impact to water quality resulting from climate change, past, present, and RFFAs, including the incremental contribution of localized increase of TSS from the post-lease activities described in the E&D Scenario, would be minor. When considering the long-lasting, widespread impacts resulting from a large oil spill, moderate cumulative effects could result.

4.5 Coastal and Estuarine Habitats

4.5.1 Affected Environment

Cook Inlet is a subarctic estuarine system approximately 350 km (218 mi) from north to south, and 200 km (124 mi) at its widest extent from east to west. Four major bays branch off Cook Inlet: Kamishak Bay, Kachemak Bay, and Turnagain and Knik arms (Renner et al., 2017). The inlet's waters are affected by numerous land-locked glaciers feeding streams and four major rivers (the Kenai, Knik, Matanuska, and Susitna) and constitutes the largest riverine drainage into the Gulf of Alaska (Benke and Cushing, 2010; Brabets et al., 2009).

Cook Inlet encompasses a wide range of coastal wetland 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 rock shorelines are more common along the eastern shorelines of lower Cook Inlet. Many shorelines of upper and central Cook Inlet support extensive salt marsh habitats. 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 wetland communities are an important conduit of energy, nutrients, and pollutants between terrestrial and marine environments, and provide resources for subsistence, sport, and commercial harvest. They also are important for recreational activities such as wildlife and nature viewing.

4.5.1.1 Coastal Habitat Types and Wetland Ecology

The wetlands of Cook Inlet perform essential physical, chemical, biological, and ecological processes and functions. Some of the most prevalent functions served by wetlands include flood flow moderation and conveyance, production and export of organic matter, maintenance of soil thermal regime, shoreline erosion and sediment control, bird and mammal support, and resident and diadromous (migratory between salt and fresh waters) fish support. Not all wetlands perform all these functions, but most wetlands contribute to one or more in varying degrees (Hall, 1994).

Estuarine and marine deepwater habitats extend across nearly the entire upper Cook Inlet and are the predominant wetland/habitat type of lower Cook Inlet. Three estuarine wetlands located along the western coast of the lower Kenai Peninsula in the general vicinity of the Proposed Action's subsea pipeline landfall, include the mouths of the Anchor River, Stariski Creek, and Deep Creek. These estuarine wetlands and deepwater habitats are influenced by adjacent tidal wetlands and water runoff with a variable salinity. From the high tide line to a depth of 30 m (98 ft), rocky habitat in lower Cook Inlet supports kelp forests of split kelp (*Saccharina groenlandica*), and bull kelp (*Nereocystis luetkeana*) (Chenelot et al., 2001). The extent of the kelp forest occurrence along this coastal area was recently mapped by Zimmermann and Prescott (2014); they also illustrated smaller and less frequent kelp beds on the western side of Cook Inlet. The majority of the other kelp forests occur further south between MacDonald Spit and Port Graham, outside of the Proposed Lease Sale Area.

Marine intertidal habitats of Cook Inlet consist of rocky substrates juxtaposed with sandy beaches, salt marshes, and tidal mud flats ranging from completely protected beaches to those with extreme wave exposure. Salt marshes are highly productive estuarine habitats that support a wide range of animal species including intertidal invertebrates, fish, birds, and mammals (Baird et al., 2007). Located on both the eastern and western coastlines of lower Cook Inlet, expansive salt marshes are found in low energy, tidally dominated areas such as heads of protected bays and fjords, behind spits, and in fringing coastal lagoons. Tidal inundation is critically important delivering nutrient-rich sediments and water to the salt marsh. Coastal salt marshes include a wide range of plant community types dominated by dense stands of terrestrial salt-tolerant plants such as herbaceous sedges (*Carex spp.*) grasses (*Puccinellia spp)*, and low shrubs (*Potentilla spp*). Baird et al. (2007) extensively mapped three salt marshes in Trading Bay, Redoubt Bay, and Chickaloon Bay. The total area mapped comprised 7,640 ha (18,880 ac), however salt marsh vegetation can be difficult to determine particularly where salt marshes gradually transition into extensive freshwater marshes (Baird and Field, 2008).

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 and are associated with major river deltas such as those found on the west side of Cook Inlet. Mudflats are a common habitat in Cook Inlet and can extend for tens of kilometers (or miles) and be >1.6 km (1 mi) wide in the intertidal zone (Saupe et al., 2005).

4.5.1.2 Freshwater Wetlands

Along the western side, immediately adjacent to and north of the Proposed Lease Sale Area, expansive mudflats and wide estuarine wetland environments are in Trading Bay, Redoubt Bay, Tuxedni Bay, and Chinitna Bay. Beyond the reach of tidal inundation, these wetlands transition into freshwater emergent wetlands where they are saturated by upland runoff, freshwater streams (including melt water from glaciers), rain, and/or groundwater. Freshwater wetlands are located along the western and eastern shores and uplands of Cook Inlet adjacent to estuarine coastal habitats and marine wetlands. The majority of freshwater wetlands are palustrine emergent wetlands characterized by erect, rooted, herbaceous hydrophytes (excluding mosses and lichens) present for most of the growing season and dominated by perennial plants. Further upland are scrub-shrub palustrine wetlands dominated by woody vegetation less than 6 m (20 ft) tall including true shrubs, young trees (saplings), and small and stunted trees exposed to severe environmental conditions.

4.5.2 Environmental Consequences of the Proposed Action

4.5.2.1 Habitat Alteration

Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, could impact deepwater habitats, estuarine, coastal, and freshwater wetlands. As discussed previously in the context of water quality, an increase in TSS and pollutants would be expected from drilling exploration and delineation wells; anchoring; installation and removal of nodes, cables, sensors, production platforms, and pipelines; vessel anchoring, and vessel and other operational discharges. Construction of the onshore pipeline and associated landfall tie-in described within the E&D Scenario, while conducted within an established pipeline right-of-way and tying into existing infrastructure, would directly impact coastal estuarine and terrestrial wetland habitat by physical disturbance resulting from land clearing and trenching activities.

Wetlands in freshwater, coastal, and marine areas are regulated by the USACE, and CWA permitting requirements mandate avoidance and minimization of impacts, which would likely result in mitigation-lessening impacts to high-value wetland habitat. BOEM expects that all activities conducted in jurisdictional wetlands would be compliant with required permits and stipulations.

An increase in TSS resulting from resuspension of sediments would temporarily increase sediment load deeper in the water column during, and for a short duration following, seafloor disturbance (Section 4.4). Small, localized turbidity plumes resulting from scouring around seafloor structures and anchors could also result. Although elevated levels of TSS reduce light availability necessary for primary production throughout the water column (Anthony et al., 2004), the upper water column should not be impacted by elevated TSS levels unless activities occur in shallow water (approximately less than 10 m). The areal extent of turbidity increase resulting from seafloor disturbance activities would be unlikely to approach the levels associated with the input of glacial flour from streams draining into Cook Inlet (Saupe et al., 2005; Segar, 1995), or the highly fluctuating ambient levels of TSS that occur daily during tidal cycles and riverine runoff (Feely and Massoth, 1982). The strong and fast tidal currents of Cook Inlet would rapidly disperse and resettle TSS resulting in short-term, localized impacts to estuarine and marine deepwater wetland habitat (Saupe et al., 2005).

Seafloor disturbance is expected to be minimized/attenuated because of the high-energy marine environment of Cook Inlet (Section 4.4), and therefore smothering of any intertidal and marine habitats would be minimized. The total area of seafloor and estuarine and marine wetland habitat affected by drilling discharges from exploration and delineation drilling would depend on the local hydrodynamics in the immediate discharge location. Short-term and localized impacts may result in close proximity to the discharge as a loss of essential wetland functions, such as supporting fish and benthic organisms, birds, and mammals, which could be interrupted until the discharge ceases and the impacted seafloor recovers (Sections 4.6, 4.7, and 4.8).

Other operational discharges from well drilling, field development and operations, and vessel discharges are authorized by the appropriate EPA NPDES permit. Specific to each discharge are testing requirements, compliance mandates, and other permit conditions required for approved offshore operations. Regulatory oversight and permit mitigations serve to ensure that little to no impact to coastal and estuarine wetland habitats are expected.

Onshore Pipeline Construction and Support Activities

Physical disturbance to estuarine and freshwater wetlands by land clearing, removal of water, native soil, rock and vegetation, and trenching activities would directly impact wetland habitat and disrupt their associated functional ecological services during and following construction. Approximately 119 ha (295 ac) of coastal intertidal, palustrine emergent and palustrine scrub-shrub wetlands (including stream and river crossings) and their functional ecological services would be directly impacted by construction of new pipeline landfalls and 80 mi of onshore pipelines.

Habitat disturbance could result from altered surface and subsurface water flow to wetlands and vegetation resulting in localized flooding, drying, impounding, and increased sedimentation. Relatively small changes in water balance can alter surface soil or groundwater sufficiently to reduce wetland size or initiate conversion of a wetland to an upland (Klein et al., 2005). Reclamation of wetland habitat is complex, site-specific, and the duration of recovery highly dependent upon the wetland type, plant species, and the local hydrologic regime (Zedler, 2000). Vegetation recolonization in successional stages would be expected with pioneering grass and weed species initiating colonization the following growing season, followed by upland vegetation and shrubs within 2–3 years, and up to 10 years for native tree species.

Impacts to wetlands from landfall and pipeline construction during development resulting from post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, would result in localized effects to coastal and freshwater wetlands, albeit with slower recovery expected for select wetland habitats.

4.5.2.2 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on coastal and estuarine habitats are described in Section A-3.3 of Appendix A. Most small, accidental spills of crude oil would have localized and relatively slight impacts. Slight damage to shorelines, vegetation, and wetlands could occur during spill drill activities as discussed in Section A-3.2.3 of Appendix A, but impacts would be localized and temporary. Heavy oiling of shorelines, substrate, and emergent vegetation resulting from a large crude oil spill would be damaging and cause long-term impacts to coastal and estuarine habitats. Spills during the winter would cause far less impact to vegetated wetlands than spills that occur during the active summer growing season. Diesel or refined product spills of any size would damage or be lethal to exposed vegetation on contact. Spill response activities could cause impact by damaging vegetation and/or spreading oil contamination further into shoreline sediments. A gas release would be expected to volatilize quickly and not result in ignition and burning of vegetation.

4.5.2.3 Conclusion

Short-term and localized impacts to coastal and estuarine habitat resulting from seafloor disturbance activities, discharges, pipeline landfalls, and onshore construction would be expected. Impacts from accidental small spills and spill drills would range from none to short-term and/or localized for coastal and estuarine habitats. The localized impacts from post-lease activities associated with LS 258 as described in the E&D Scenario would be minor. These minor impacts would not result in any long-lasting detrimental effects on the overall ecological functions, species abundance, or composition of marine or freshwater wetlands or plant communities of Cook Inlet, and most wetland habitat would be expected to recover following decommissioning.

The addition of a large oil spill and spill response could increase the impact to coastal and estuarine habitats to major, depending upon the location and timing (Section A-3.3, Appendix A). Contamination of freshwater and marine wetland sediments could continue to expose wetland vegetation to potentially toxic levels of hydrocarbons, particularly in remote areas where access for immediate spill response is limited. Oil stranded in freshwater and marine wetland sediments that is not in contact with flowing water is resistant to biodegradation and could be expected to persist for decades.

4.5.3 Environmental Consequences of the Alternatives

Potential impacts on coastal and estuarine habitats under all action alternatives would not differ substantially from those described for the Proposed Action. Coastal and estuarine are transitional habitats located between deepwater and upland habitats and are more influenced by their association with land than the marine systems. These alternatives would not change the total level of activity under the E&D Scenario, and none of the restrictions identified in these alternatives would be expected to change the likelihood or severity of impacts on coastal and estuarine wetlands. Consequently, impacts of these alternatives on coastal and estuarine habitats would be the same as those for the Proposed Action — minor for E&D Scenario activities, accidental small spills, and spill drills. The addition of a large oil spill and associated spill response could increase the impact to coastal and estuarine habitats to major, depending upon the location and timing of the spill.

4.5.4 Cumulative Effects

Past, present, and RFFAs that could affect coastal and estuarine habitats include oil and gas, vessel traffic, marine transportation, ports and terminals, mining, residential and community development, oil spills, and climate change. Coastal and estuarine habitats surround Cook Inlet and consequently, all nearshore and onshore activities have the potential to disturb or harm coastal and estuarine habitats and terrestrial wetlands. Potential impacts to coastal and estuarine habitats from an increase in TSS, turbidity, and pollutants from operational, vessel, residential and municipal discharges; habitat loss and impacts from nearshore and onshore facility and community related construction; and changing climate have occurred in the past, are presently occurring, and are anticipated to continue in the future.

Increases in TSS, turbidity and pollutants from operational discharges from oil and gas activities, mining activities, vessel discharges, effluent from existing municipal and industrial discharges, and routine operations at port facilities all increase pollutant loadings in marine coastal and estuarine habitats. Most current discharges are not in the immediate vicinity of the Proposed Lease Sale Area, but the effects of additional operational discharges occurring in Cook Inlet could overlap in time and space having an additive effect. The types of cumulative impacts from elevated TSS levels would be as those described for the activities associated with the E&D Scenario. Operational discharges, including vessel discharges, are regulated and require either a federal (NPDES) or a state (Alaska Pollutant Discharge Elimination System

(APDES)) permit. Regulatory oversight coupled with the rapid dispersion and dilution of discharges in Cook Inlet would result in little to no cumulative impact.

Nearshore and onshore development of oil and gas facilities and pipelines, mining, residential, commercial, public and military facilities, airstrips, and other infrastructure have impacted coastal and estuarine habitats and terrestrial wetlands. Loss and irreversible impacts to coastal and estuarine habitat and terrestrial wetlands have resulted from ground disturbance, removal of vegetation, wetland fill, and alteration of water and wetlands resulting in ponding and/or drying. The 119 ha (295 ac) of wetland disturbance resulting from 129 km (80 mi) of onshore pipeline construction identified in the E&D Scenario, although localized and of minimal size, is additive to wetland disturbance and loss from other activities increasing the total acreage of coastal and estuarine habitats and terrestrial wetlands affected.

The impacts to coastal and estuarine habitats from a large oil spill would have short- to long-term and localized to widespread impacts (Section 4.5.2). Appendix A considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. The magnitude of impacts expected from such repetitive spills may increase to severe depending on the timing, location, environmental conditions, and other factors surrounding the spill and release event(s). Contamination to estuarine wetlands and sensitive shorelines from hydrocarbons has the greatest potential for long-term, widespread impacts by impacting highly productive wetland habitat and marine sediments.

Impacts from a warming climate that have been observed in Alaska include earlier snowmelt, reduced sea ice, glacial retreat, warmer/melting permafrost, drier landscapes, increased wildfires, and more extensive insect outbreaks. These changes may result in lower soil moisture due to increased evaporation during warmer summer months. Additionally, a precipitation shift from snow to rain could lead to less water stored as snowmelt, which is an important water source for wetlands in the spring and summer. In turn, less water storage could lead to drier meadows or bogs, and possibly fewer terrestrial wetlands. Also, projected rising sea levels could lead to the loss of tidal wetlands and the ecological services they provide.

Warmer temperatures and less precipitation during the growing season would potentially affect the onshore vegetation and wetlands in the drainage of, and adjacent to, Cook Inlet. The forested Cook Inlet lowlands that currently cover the western half of the Kenai Peninsula could become a dryer grassland with mixed grass-shrub prairie (SNAP, 2012). This portion of the Kenai Peninsula includes the 119 ha (295 ac) of wetlands expected to be impacted from the 129 km (80 mi) of onshore pipeline construction associated with the Proposed Action.

Overall, the cumulative impact to estuarine and coastal habitats resulting from past, present, and RFFAs and a changing climate, including the incremental contribution from LS 258, as described in the E&D Scenario, would be minor. This includes both offshore activities and the short-term, localized contribution of onshore wetland disturbance from pipeline construction associated with the E&D Scenario. Although temporary, short-term, localized impacts would be expected from E&D activities, federal and state regulatory mitigation would ensure that little to no measurable impacts to coastal and estuarine habitats would ensue. When considering the impacts from large oil spills, the impact to coastal and estuarine habitats could increase to major.

4.6 Fish and Invertebrates

4.6.1 Affected Environment

Cook Inlet is home to many species and communities of fish and invertebrates in habitats ranging from the intertidal zone to the open ocean. Lower Cook Inlet is an upwelling area influenced by fresh and marine water mixing (Abookire et al., 2000; Sambrotto and Lorenzen, 1987). Pelagic species are associated with the water column and include very small algae (phytoplankton), zooplankton, and fish. Nutrient availability and tidal activity heavily influence the distribution of these organisms. Benthic communities include the plants, fish, and invertebrates that live on or in the seafloor; depth and sediment composition play important roles in their distribution. Some species of fish and invertebrates are harvested for subsistence, personal, or commercial use, while other non-harvested prey species help support a healthy ecosystem structure.

Individual population size for fish and invertebrates can vary throughout Cook Inlet and over time. Broad community changes can be the result of climate changes, and these shifts in community structure can have wide-ranging effects on the food web. In the 1970s, the coastal ecosystem of the Gulf of Alaska underwent a shift from a community dominated largely by crustaceans to one dominated by several species of fish (Anderson, 2000; Anderson and Piatt, 1999; Ware, 1995). Range expansions can bring new species of fish and invertebrates into Cook Inlet, and community structures can be highly malleable. Changes in the lower trophic community due to regime shifts during the timespan considered in the E&D Scenario are likely to echo throughout the food web (Hare and Mantua, 2000).

4.6.1.1 Pelagic Fish and Invertebrates

Organisms that live in the water column include plankton, which are transported by currents, and free-swimming animals like fish. Plankton can include small algae called phytoplankton that rely on light availability, and zooplankton, which are the small animals that eat phytoplankton. Some species are only pelagic during larval stages. The pelagic habitat of Cook Inlet is highly productive, especially in the spring and summer when plankton blooms occur. Productivity remains high throughout the summer due to tides and nutrient-rich benthic sediment mixing (Piatt, 2002). Plankton tend to have rapid growth and reproduction rates coupled with short life spans (Abbriano et al., 2011), and are an important part of the food web because they provide energy and prey for higher-level predators like fish and birds.

Many species of fish occupy the pelagic region of Cook Inlet. Seasonal migrations are common. Some pelagic fish are anadromous, which means they live part of their life in freshwater and part in the marine environment; other species live their entire lives in the ocean environment. Forage fish, which can be either anadromous or marine residents, are a particularly vital link in the regional food web because they are energy-rich prey for fish, birds, and mammals (Abookire and Piatt, 2005; Springer and Speckman, 1997).

Anadromous fish such as salmon, smelt, and eulachon, are often seasonally abundant due to their spawning migrations when adults return to freshwater streams to reproduce. The timing of these migrations are species dependent but can also be affected by temperatures and environmental conditions. For example, longfin smelt are influenced by the temperatures of the freshwater streams and their migration timing can vary from April through December, while eulachon runs are mostly in April and May (ADF&G, 2020b; Bartlett, 2012). Salmon run migration depends on species and can occur from May through November, but the highest abundances are generally in June–August. Eggs develop in freshwater streams, hatch, and then the juveniles drift downstream where the young fish enter the marine environment to grow to maturity. Cook Inlet is a migratory corridor and early life rearing area for all five species of Pacific salmon (NPFMC, 2018), and contains many freshwater streams that are important for spawning. 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.

Pelagic marine resident fish include Pacific sand lance, capelin, and Pacific herring. These fish live in the marine environment year-round but may still be concentrated in specific areas during spawning. These fish, along with smelt and eulachon, are also classified as forage fish because they are an important food source for higher-level predators. Forage fish tend to school, often in nearshore areas, and spawn in or near the intertidal zone. They feed on zooplankton and are in turn fed upon by other fish, birds, and mammals, especially when they are present in large spawning aggregations. Changes in forage fish ecology have been linked to changes in predator populations (Brown, 2002; Piatt, et al., 2020; Robards et al., 1999). While abundance and distribution of these schooling fish varies, forage fish occur throughout Cook Inlet with fish densities greatest during summer. Both capelin and Pacific sand lance have ranges over most of Alaska (Mecklenburg et al., 2002). Pacific sand lance are abundant in shallow, nearshore areas that are typically sandy or fine gravel in the intertidal zone and will sometimes bury themselves in the sand. Pacific herring occur in large schools in Cook Inlet from the spring through the fall. Spawning occurs in the spring in shallow intertidal and subtidal zones. Herring spawn extensively along much of the Shelikof coast of Kodiak Island and the southern Alaska Peninsula, areas that are outside the Proposed Lease Sale Area but could be impacted by a large oil spill (Hollowell et al., 2016; Mecklenburg et al., 2002).

4.6.1.2 Benthic Fish and Invertebrates

Intertidal and shallow subtidal communities of eastern lower Cook Inlet are similar to those in the Gulf of Alaska, while communities in western lower Cook Inlet more closely resemble those in subarctic and Arctic seas (Foster et al., 2010; Lees et al., 1980), although some overlap occurs. Dominant invertebrate species within intertidal and shallow subtidal communities include grazers (e.g., sea urchins, chitons, and limpets), filter feeders (e.g., mussels, clams, anemones, and sponges), and predators/ scavengers (e.g., sea stars, snails, and crabs) (Foster et al., 2010; Jones et al., 2019). More specifically, rocky habitats are dominated by sedentary filter feeders, like anemones and mussels, but also have crabs, snails, sea stars, and urchins. Sandy, silty, and muddy intertidal substrates also have grazers and filter feeders, but are more likely to have worms, amphipods, and clams (Mundy, 2005). Deeper sandy areas are dominated by razor clams and muddy beaches are typically dominated by several species of clams and worms. Areas with a lot of shell debris generally have the most diverse communities (Lees et al., 1980; NOAA, 1977). Deeper communities, which exist beneath the normal tidal flux zones, often have crabs, sea urchins, shrimp, kelp, and fish as well as mollusks and worms (Lees et al., 1980; NOAA, 1977). Generally, these varied communities are prey for groundfish and mobile scavengers, like crabs, and are therefore necessary components of the ecosystem. Several species of invertebrates found in Cook Inlet are the targets of subsistence, sport, or commercial fisheries.

Many species of crabs and shrimp found in Cook Inlet are important for human use. Tanner, king, and Dungeness crabs, which are all harvested commercially in Alaska, are found in the Proposed Lease Sale Area. Tanner crabs are widely distributed throughout the region on the continental shelf and in coastal waters. 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, 1988; NOAA, 1977). Dungeness crabs are widely distributed subtidally and prefer a sandy or muddy bottom in the sea but can be found in estuarine environments. Northern and humpy shrimp are captured in the commercial trawl shrimp fishery in Alaska. Coonstripe and spot shrimp are commonly found in Cook Inlet and are the target of various pot shrimp fisheries around Alaska.

In addition to the previously discussed crustaceans, littleneck, razor, and butter clams are bivalve mollusks commonly found in commercial and sport fisheries. They live in the sediments of sandy and rocky beaches, where they can filter feed during high tides. Cook Inlet has many areas, such as Kachemak Bay, where clams are harvested for the personal use fishery. Weathervane scallops, another filter feeding mollusc, are found on seafloors of sand, gravel, and rock in subtidal areas. Like most filter feeders, molluscs are sensitive to changes in water quality, especially from oil.

Fish, both benthic and pelagic, are important components of the food web because they feed on lower trophic organisms such as plankton, and serve as prey for other fish, birds, and mammals. In contrast to pelagic fish, benthic fish remain near the seafloor for much of their lives. Spawning and early life development, however, may be in pelagic waters. Commonly occurring species or families of fish in Cook Inlet include cods, flatfish, rockfish, sculpins, lingcod, greenlings, poachers, skates, and pricklebacks (Mecklenburg et al., 2002; NPFMC, 2019). Most benthic fish are resident year-round. Generally, they prey on invertebrates or fish and are found in a variety of habitat types and depths throughout Cook Inlet. Some species are commercially important, like Pacific cod, Pacific hake, Pacific halibut, and walleye pollock. Pacific cod form aggregations during the peak spawning season, which extends approximately from January through May (NPFMC, 2019). Walleye pollock occurs throughout the Proposed Lease Sale Area, with a large spring spawning aggregation in Shelikof Strait. This commercially harvested species can sometimes inhabit pelagic waters but is managed as a groundfish. Pacific halibut, which are found throughout Alaskan waters, inhabit much of the Proposed Lease Sale Area. Spawning takes place in waters deeper than 350 m (1,148 ft) along the continental shelf in the winter. Rockfish, a grouping that can include several species, are present throughout most Alaskan waters, often in rocky areas. They are long lived and are present in Cook Inlet year-round.

4.6.2 Environmental Consequences of the Proposed Action

4.6.2.1 Noise

Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, which produce noise impacts to invertebrates and fish include seismic surveys, platform installation, drilling, and vessel traffic. Fish rely heavily on sensory perceptions of sound and pressure to feed, avoid predation, swim, and communicate. There could be behavioral and physical effects to mobile fish at less intense sounds, and acute effects for individuals within a few meters of an intense sound source (McCauley et al., 2003). Death or physical damage can occur if animals are unable to escape close range exposure to intense noise, particularly from activities like seismic surveys or pile-driving (Day et al., 2017; McCauley et al., 2017). Injury to the auditory nerve, hair cells, or swim bladder can be temporary or permanent (Halvorsen et al., 2012). If recovery from injury is slow or does not occur, individuals would be susceptible to physical impairment, disease, and predation. Planktonic organisms and immobile invertebrates would not be able to leave the area of noise exposure, but fish capable of swimming away will likely escape the area. Generally, noise impacts would affect a few individuals but would not result in changes to overall population or community structure.

Noises from drilling tend to be stationary, less intense, and persistent when compared to noises from seismic surveys, which are in motion, more intense, but short-term. General vessel noise tends to be transient and very localized but doesn't have the acute noises associated with seismic surveys. Although exposure to intense noise may harm planktonic organisms within a few meters of the sound (Dalen and Knutsen, 1987; McCauley et al., 2003), these communities have short lifecycles with high reproductive potential and can recolonize from adjacent areas through currents, so population level impacts are unlikely (Abbriano et al., 2011). The intensity of drilling sound is less than airgun arrays, and fish and mobile invertebrates may avoid the area around the wellsite until they become habituated (Fewtrell and McCauley, 2012). If this zone of displacement is located in important spawning or feeding habitat, affected species may not be able to access preferred habitat.

Impacts from noise to fish and invertebrate communities may have acute effects on individuals close to the noise source, but overall population impacts are not expected because the noises will be temporary, and individuals will habituate or leave the area. Seasonal restrictions on seismic surveys may limit some of the effects of noise on organisms near spawning grounds. The area of impact is dependent on a variety of factors, including distance from the source and the bathymetry of the local area, but impacts from noise would generally be localized and short-term.

4.6.2.2 Habitat Alteration

Alteration of habitat for fish and invertebrates could occur from installation of drilling structures and pipeline trenching. These impacts, aside from the presence of drilling platforms, would primarily occur during construction and decommissioning and would not be present throughout the life of the E&D Scenario. Changes in fish and invertebrate communities would be short-term relative to the E&D Scenario lifespan and would generally be limited to the area immediately around the footprint of the activity. The area of habitat altered would be a very small portion of the overall fish and invertebrate habitat available in the Proposed Lease Sale Area.

Placement of drilling structures and pipeline trenching would alter the seafloor habitat and could crush benthic species, resulting in injury or mortality to individual organisms (Daigle, 2011; Manoukian et al., 2010; Montagna et al., 2002). Fish are likely to swim away from the area of disturbance, which would decrease the number of individuals affected by drill structure placement and pipeline laying. Many benthic invertebrate species are immobile or slow moving and cannot leave the area. Construction could kill or injure any animals caught in the footprint of the activities, although the area affected would be very small (~0.14 ac/platform, and 291 ac for pipelines) relative to the area of the Cook Inlet Proposed Lease Sale Area (~1 million ac). Platform installation and pipeline trenching may locally and temporarily increase turbidity as sediments on the seafloor are mixed into the water column (Section 4.4). This could affect marine invertebrates and fish by decreasing visibility, impacting predation success, clogging gills, and smothering seafloor communities (De Robertis et al., 2003). Turbidity would likely return to ambient levels once construction activities are completed; for the majority of the life of the project, local turbidity would not be increased.

Although some habitat may be lost when drilling structures are placed, addition of structures as new habitat may mitigate impacts of benthic habitat loss for some species (Daigle, 2011; Fujii, 2015). Platforms, once in place, could provide hard substrate habitat for some species, though the immediate area around the structures may have very different habitat functions and biological communities than in the pre-construction period (Gallaway and Lewbel, 1982), especially if hard substrate is added to an area that was previously sandy or muddy. Fish and benthic organisms likely would resume use of the area around and on platforms after the initial construction is over (Fabi et al., 2004; Stachowitsch et al., 2002). Lights associated with structures would illuminate surrounding waters and could attract prey organisms, providing an enhanced foraging environment (Keenan et al., 2007; Shaw et al., 2002).

Based on post-lease activities described in the E&D Scenario, a small area of the seafloor habitat, relative to the overall area of habitat available to fish and invertebrates in Cook Inlet, could be altered by platform installations or pipeline trenching. Although presence of drilling structures will span the life of the E&D Scenario, impacts would be highly localized to the structures.

4.6.2.3 Disturbance

Post-lease activities resulting from LS 258, described in the E&D Scenario may disturb fish and invertebrates through water intake structures, discharges associated with exploration drilling, and vessel traffic. Activities causing disturbance would occur throughout the life of the E&D Scenario.

Water intake structures on platforms can trap plankton and larval or weak-swimming juvenile fish, resulting in localized impacts including decreased biomass, diversity, and productivity (Choi et al., 2012). Water intake structures usually do not affect benthic species, which live on the seafloor and away from the intake area, and adult pelagic fish, which can swim away. Discharged water may be a different temperature than the ambient levels, and may contain trace amounts of chemicals, which could shock or kill some individual organisms that are right next to the discharge point. Discharged water would rapidly dilute, mixing to background levels. Water intake structures may negatively affect zooplankton and larval fish throughout the life of the scenario, but these impacts would be limited to a discrete area around the intake structures. Regulatory permitting requirements under NPDES would minimize the effect of water treatment discharges on plankton and fish larvae.

Discharge of drilling fluids and cuttings can disturb the water column and seafloor immediately around the drilling area (Section 4.4). Where drilling fluids and cuttings settle on the seafloor, there could be localized impacts on the benthos and prey organisms through chemical toxicity, change in sediment texture, or burial of individual organisms (Blackburn et al., 2014; Neff, 2010). 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. Juvenile and adult fish, which would swim away and eventually reoccupy the area, are not likely to experience lethal effects from exposure to permitted discharges (Neff, 1987). The discharge of drilling fluids and cuttings is regulated and is not likely to cause persistent toxic effects in fish or invertebrate communities near the discharge. In high-energy environments such as Cook Inlet, where accumulations of cuttings and toxic concentrations are not expected (Section 4.4), impacts to fish and invertebrate populations are unlikely, since only small numbers of individuals may be affected. Biological effects of offshore developments would be limited and highly localized, with benthic recovery occurring after drilling ceases. Changes in benthic communities could change the prey availability for predators, but bioaccumulation of contaminants is not likely (Neff, 2002). Benthic communities would likely recover once drilling has ceased, which would minimize long-term impacts to fish and other invertebrates.

Fish and invertebrates in the coastal and marine environments could be disturbed by the presence and passing of vessels associated with the E&D Scenario. Pressure waves from vessel hulls could displace or injure larval fish and plankton (Hawkins and Popper, 2012, 2017). Vessel traffic impacts would be short-term, transitory, and limited to the areas immediately surrounding a vessel. Plankton are very common throughout Cook Inlet, so the impacts on individuals would not result in impacts to the overall populations.

4.6.2.4 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on fish and invertebrates are described in Section A-3.4 of Appendix A. Most accidental spills or spill drills would be small, localized, and have relatively limited impacts to populations of fish and invertebrates. Small spills would not have population level impacts and would impact relatively few habitats. A large oil spill could have similar toxic effects on fish and invertebrates as described for small spills, but the magnitude and severity would be greater. Toxic effects on organisms could occur in the immediate area of a spill or in areas where oil accumulates. A large spill, depending on the season and location, could be difficult to contain and might result in longer-term habitat impacts, as well as affecting more individuals than a small spill. Prolonged exposure, whether through repeated small spills or extended exposure to a large spill, could have an increased adverse effect on fish and invertebrates because residual oil can build up in sediments. Migratory fish could be affected by a large oil spill in spawning and rearing habitats. Effects of a large spill in nearshore intertidal areas could persist for generations and may be compounded by affecting more than one life stage. The impacts of a large spill could be widespread, long-lasting, and would require spill response and cleanup, which itself can affect organisms through use of dispersants and mechanical recovery methods (Section A-3.4, Appendix A). These long-lasting effects occurring in discrete areas are not likely to affect the majority of the Proposed Lease Sale Area or cover the entirety of available habitat in Cook Inlet, thus limiting the severity of effects. Recovery would be expected in the affected area, possibly after many years, while unoiled areas would not be impacted. A large gas release could cause death or physical damage to organisms in the immediate vicinity.

4.6.2.5 Conclusion

Impacts from noise, habitat alteration, disturbance, accidental small oil spills, and spill drills on fish and invertebrates in Cook Inlet would be short-term and localized to the area of activity. While certain impacts would occur over many years (such as habitat alteration through addition of platforms or presence of vessels in the region), the area of effect would be limited to the immediate vicinity of the structure or activity. While impacts may be acute for individuals present in the area of an impact (for example, damage caused by drill structure placement), changes to the overall population dynamics are unlikely given the high likelihood of recolonization from adjacent areas. In general, most impacts are not anticipated to result in a clear, long-lasting change in the resource’s function in the ecosystem. A large oil spill may increase impacts on fish and invertebrates since population structures may change, resulting in long-lasting and/or widespread effects. The post-lease activities described in the E&D Scenario, which generally are expected to have minor impacts, could have up to moderate impacts on fish and invertebrates if a large oil spill occurs.

4.6.3 Environmental Consequences of the Alternatives

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

Potential impacts on fish and invertebrates under these alternatives would not differ substantially from those described for the Proposed Action. Excluding some OCS blocks from the Proposed Lease Sale, as with Alternative 3A, would preclude impacts from occurring in the excluded area. Limiting seismic surveys and decreasing noise from platforms near major anadromous streams, as with Alternatives 3B and 3C, would eliminate or decrease the impact of seismic sounds for a large part of the year, which could be beneficial to anadromous fish on spawning migrations. However, since the organisms in this area are similar to those throughout Cook Inlet, the mitigation alternatives do not change the types or severity of overall impacts on fish and invertebrate communities for Cook Inlet compared to the Proposed Action. Under this alternative, impacts to fish and invertebrates from E&D Scenario activities, accidental small spills and spill drills would remain minor, but could range up to moderate if a large spill occurs.

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

Potential impacts on fish and invertebrates under this alternative would not differ substantially from those described for the Proposed Action. Excluding some OCS blocks from the Proposed Lease Sale, as with Alternative 4A, would preclude impacts from occurring in the excluded area. Prohibiting drilling discharges within 1,000 m (3,280 ft) of critical sea otter habitat, as with Alternative 4B, may benefit those areas of benthic habitat. However, since the organisms in this area are similar to those throughout Cook Inlet, this alternative does not change the types or severity of overall impacts on fish and invertebrate communities for Cook Inlet compared to the Proposed Action. Under this alternative, impacts to fish and invertebrates from E&D Scenario activities, accidental small spills and spill drills would remain minor, but could range up to moderate if a large spill occurs.

4.6.3.3 Alternative 5 – Gillnet Fishery Mitigation

Potential impacts on fish and invertebrates under this alternative would not differ substantially from those described for the Proposed Action. Reducing the level of seismic activities during peak salmon spawning times would benefit those fish populations. However, since the organisms in this area are similar to those throughout Cook Inlet, this alternative does not change the types or severity of overall impacts on fish and invertebrate communities for Cook Inlet compared to the Proposed Action. Under this alternative, impacts to fish and invertebrates from E&D Scenario activities, accidental small spills and spill drills would remain minor, but could range up to moderate if a large spill occurs.

4.6.4 Cumulative Effects

Sources of cumulative impacts on fish and invertebrates include oil and gas operations, vessel traffic, oil spills, and climate change (Section 3.2). Most effects of the post-lease activities described in the E&D Scenario are temporary and unlikely to substantially overlap in time and space with the actions described in the Past, Present, and Reasonably Foreseeable Future Activities (Section 3.2). However, where the actions do overlap, impacts from noise, habitat alteration, and disturbance may be expected, and are likely to be similar to the effects described for the Proposed Action. Appendix A also considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. Large or chronic oil spills could have a cumulative effect on fish and invertebrate communities in Cook Inlet through reduced fitness or, if chronic exposure occurs in a given area, changes in population and community structure.

Climate change is likely to have a widespread, persistent impact on the habitat and distribution of fish and invertebrates. Warming oceans, increased acidity, and other factors associated with climate change could cause or contribute to further regime shifts in fish and invertebrate communities of Cook Inlet (Cheung et al., 2009; Sherman et al., 2009). Ocean acidification can increase mortality, disrupt seasonal plankton production, make it more difficult for fish and invertebrates to grow and reproduce, and increase the effects of harmful algal blooms (Fabry et al., 2009; Tatters et al., 2012). Range expansions may bring new species into Cook Inlet, while other species may become less prevalent. These changes could also allow invasive species to colonize previously unavailable areas. Invasive species, if established in Cook Inlet, could disrupt the local food web through increased competition for resources, preying on native species, or introduction of pathogens. These cumulative modifications can result in changes in prey and nutrients available for predators higher in the food web such as fish, birds, and mammals. Shifts in the food web as a result of changing climate could result in major ripple effects, with some predators forced to eat non-optimal prey items, or preferred feeding spots becoming unavailable. Some species may benefit from shifts in the environment. The presence of different species in Cook Inlet would affect how the Proposed Action's effects are observed. However, a more precise description of such changes is unduly speculative at this time given the complexity of these issues and the lack of precision in climate change models. Any changes in fish and invertebrate communities that occur through time would be assessed in each successive EP- and DPP-specific NEPA review process.

While many cumulative impacts are foreseeable, the addition of the Proposed Action to the Past, Present, and RFFAs (Section 3.2) is not expected to have widespread or persistent impacts to the health or community structure on the fish and invertebrates living in Cook Inlet. The potential impacts of the Proposed Action would likely be small, incremental contributions to the overall cumulative effects that are limited to localized areas and times. Where impacts may overlap the life of the E&D Scenario, such as climate change or increased vessel traffic, the Proposed Action will have no discernable additive or synergistic effect that was not already considered in the effects analysis. Although the cumulative impacts to fish and invertebrates is likely to be major, primarily due to climate change, the incrementally additive impact of the Proposed Action in the context of these Past, Present, and RFFAs is negligible.

4.7 Birds

4.7.1 Affected Environment

Cook Inlet is diverse in bird habitat types and is a flight corridor for migrating birds. This habitat diversity supports a wide variety of birds, including marine birds, landbirds, raptors, and others (Arimitsu et al., 2018; Day et al., 2005a).

Almost 250 bird species, half of Alaska's total, occur in lower Cook Inlet during some part of the year (West et al., 2011). Large populations fly up and across Cook Inlet during spring and fall migrations. Many stop to rest and feed in large aggregations, to stage in preparation for migration, or to gather to molt post-breeding. Many also breed in summer or winter over in lower Cook Inlet. Several bird species are considered endemic to Cook Inlet in that they occur only there during all or parts of their life cycles, including Kenai song sparrow, Tule white-fronted goose during breeding, and Pribilof Island rock sandpiper 20 during winter (The Nature Conservancy, 2003).

"Marine birds" as referenced herein are the waterbirds that use lower Cook Inlet marine habitats: seabirds, waterfowl, loons and grebes, and shorebirds. Marine bird densities are generally high throughout the year. Community composition, however, varies considerably between seasons and throughout the year (Renner et al., 2017). Marine birds consume a variety of prey, are sometimes top predators, and are highly responsive to a dynamic marine environment (Schmutz, 2014). Marine bird communities in Cook Inlet are somewhat stratified in their distribution along an east/west gradient, reflecting the profiles of water flow and salinity/temperature, and the corresponding productivity of lower trophic food sources (Renner et al., 2017; Piatt and Harding, 2007).

20 Pribilof Island rock sandpiperis the nominate subspecies (*Calidris ptilocnemis ptilocnemis*) of the four recognized subspecies of rock sandpiper.

Large numbers of seabirds depend on lower Cook Inlet throughout the year (Piatt and Harding, 2007). Seabirds include species that typically depend on foraging in one or more of several ways at the sea's surface or by diving to various depths after various prey types, only coming to land to breed. In summer, several large breeding colonies total hundreds of thousands of common murre, black-legged kittiwake, glaucous-winged gull, and puffins (e.g., Chisik Island, Gull Island, Barren Islands). Additionally, tens of thousands or more other seabirds that breed in the southern hemisphere (e.g., sooty shearwater) spend their nonbreeding months feeding in Cook Inlet during our northern hemisphere summer (West et al., 2011).

Seabird populations in Alaska are strongly influenced by food supply (Arimitsu, et al., 2019; Piatt et al., 2020). Most lower Cook Inlet seabirds depend on small forage fish and some are generalists on both fish and plankton. Fish-eaters include some of the most abundant lower Cook Inlet seabird populations: surface-feeding black-legged kittiwake, diving common murre, and diving Kittlitz's and marbled murrelets. Common seabirds that typically feed on invertebrate resources as well as fish include diving tufted and horned puffins, and surface-feeding or shallow-diving glaucous-winged gull, northern fulmar, and shearwater species (which can dive to 60–70m; Burger, 2001). Several seabird populations in Cook Inlet have recently been undergoing extreme fluctuations in mortality, productivity, and foraging patterns. These responses, and a general relationship to food availability, have also been tied to environmental and anthropomorphic perturbations in the Gulf of Alaska (GOA), including the largest marine heatwave on record (2014–2016) and the lingering effects of the1989 *Exxon Valdez* Oil Spill (EVOS) (Cushing et al., 2018; Goyert et al., 2018; Esler et al., 2018). Birds that are narrowly dependent on forage fish may be particularly vulnerable to food-related population impacts; in 2015–2016 a massive die-off of common murres, along with repeated reproductive failure, was documented in the GOA, while the omnivorous tufted puffin appeared to be more resilient (Piatt et al., 2020; Schoen et al., 2018).

Waterfowl include ducks (both diving sea ducks and "dabbling" surface-feeding ducks), geese, and swans. Waterfowl, especially sea ducks, are abundant in the waters of lower Cook Inlet. Waterfowl summer breeding and spring and fall migration habitats are associated with plentiful mudflats, coastal salt marshes or other wetlands. Wintering areas depend on availability of open water, especially in nearshore marine habitats. Sea ducks such as scoters and harlequin duck are diving ducks that depend on marine benthic invertebrates for food most of their lives. Scoters are common in lower Cook Inlet and often observed in flocks or "rafts" of up to a few hundred birds. In April and May waterfowl move to adjacent or distant (beyond lower Cook Inlet) land or freshwater to breed (USFWS, 2011; Safine, 2005). Some non-breeders or failed breeders remain in lower Cook Inlet marine waters year-round.

Lower Cook Inlet is also important to Steller's eider, a sea duck that may be particularly vulnerable because of its limited population. The Alaska breeding population, numbering a few thousand birds at most, is listed as threatened under the ESA (62 FR 31748, June 11, 1997). Steller's eiders breed in the Arctic and subarctic tundra beyond the Proposed Lease Sale Area. Alaskan-breeding birds winter in southwest Alaskan waters, however, and mingle in lower Cook Inlet with many more thousands of non-listed Steller's eiders from Russia. These birds begin a 3-week flightless molt in late July in southwestern Alaskan waters, and lower Cook Inlet is their eastern-most extent. Then from late August to late April or early May, Steller's eider winter in these marine waters. Numbers typically peak in January through February (Larned, 2006). In the winter in lower Cook Inlet, Steller's eider are typically concentrated in nearshore waters off Ninilchik, Kachemak Bay, and northern Kamishak Bay, but also regularly occur miles offshore (Martin et al., 2015; NOAA, 2002).

Coastal salt marshes are particularly important lower Cook Inlet habitat for other species of waterfowl, including dabbling ducks (e.g., mallard and pintail), geese, and trumpeter swan. The only known breeding habitat of the Tule white-fronted goose, subspecies of greater white-fronted goose, is in Cook Inlet. Important molting areas for Tule white-fronted goose are found on the west side of Cook Inlet. A significant portion of the world population of the Wrangell Island snow goose uses Cook Inlet during spring migration.

Loons and grebes are diving birds that share characteristics of both seabirds and waterfowl. Pacific and common loons and red-necked grebes are marine birds that breed in territorial pairs on freshwater lakes all around the Cook Inlet area in the summer months (Renner et al., 2017; West et al., 2011). These and red-throated loon, which is believed to be declining, winter in Cook Inlet marine waters (Schmutz, Pers. Comm., 2017). Loons and grebes are typically found singly or in small groups diving for forage fish.

Shorebirds are typically long-legged wading birds that, like waterfowl, are known in coastal Alaska for the large flocks many of them form during north and south migrations. Cook Inlet migrations often provide the last significant area of ice-free shoreline habitat in spring for many shorebirds migrating to Western Alaskan and Arctic breeding grounds: hundreds of thousands can “stack up” in places like Redoubt and Kachemak bays awaiting better conditions to the west and north (Gill and Tibbetts, 1999). For the entire biogeographical region known as the Northwest Interior (or Boreal) Forest, stretching from the Yukon Flats to Kachemak Bay, Cook Inlet hosts the highest seasonal concentration of shorebirds (ASWG, 2019). Over 30 species of shorebirds, including great numbers of western sandpiper, dunlin, and long- and short-billed dowitchers, depend on the intertidal habitats of lower Cook Inlet in particular, to replenish fat stores during migration. Virtually the entire population of Pribilof Island rock sandpiper winters along the shores of Cook Inlet (Gill and Tibbetts, 1999). A significant percentage of the world population of Hudsonian godwit breeds in upper Cook Inlet, passing through lower Cook Inlet to get there, and several shorebird species breed in the lower Cook Inlet area itself. In the spring months, red-necked phalarope is among the most common lower Cook Inlet marine bird species, and a few may stay year-round (Renner et al., 2017). Phalaropes are unique among shorebirds in that they swim in open water as they forage on plankton at or near the surface.

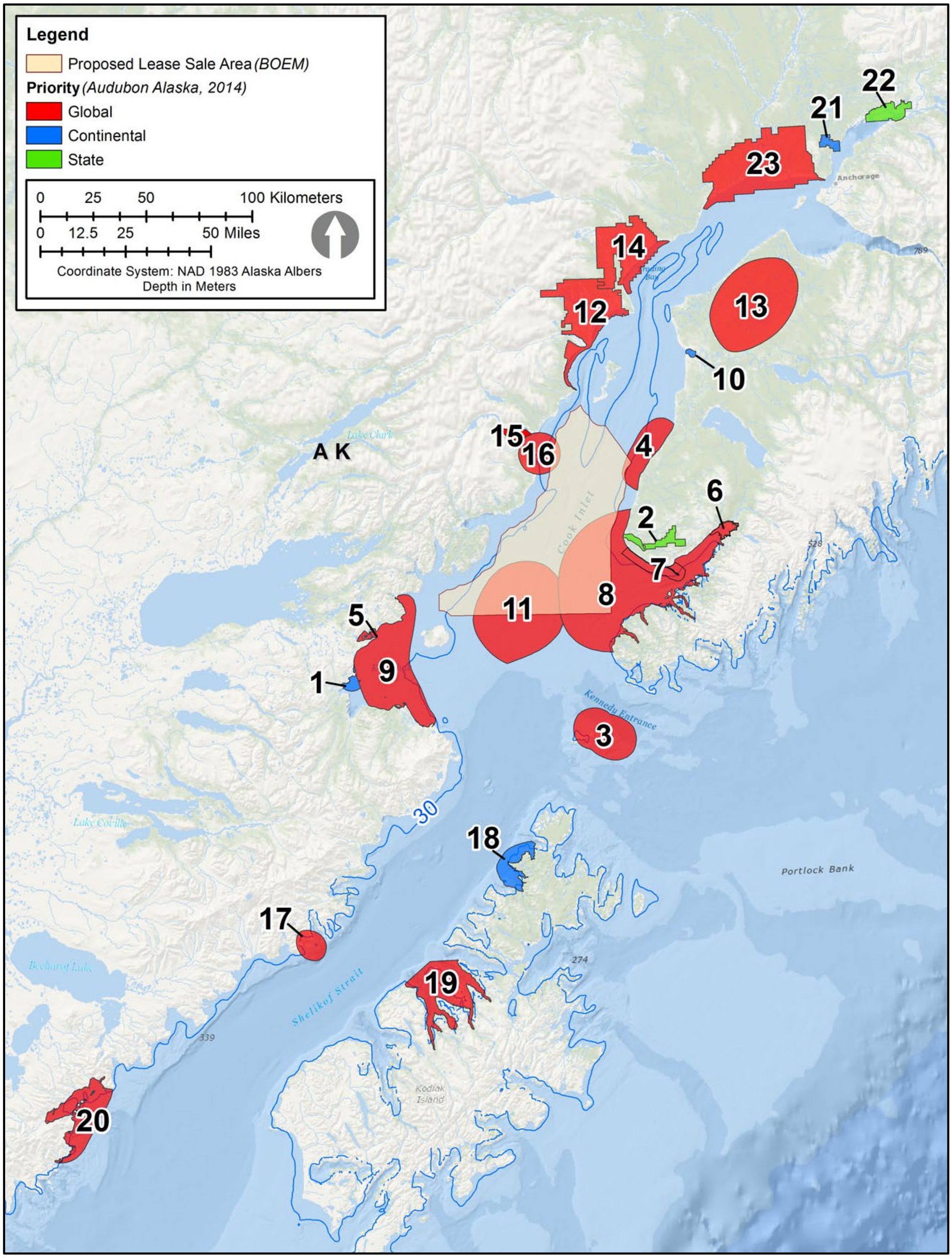
Besides waterbirds, the lower Cook Inlet area supports large numbers of landbirds like passerines (perching birds), raptors and owls, and sandhill crane. Dozens of species of passerines, including warblers, thrushes, and sparrows, stop over during their largely nocturnal migrations. Many are summer-breeding or year-round residents too (e.g., kinglet and chickadee species, common raven) (Day et al., 2005a; ADF&G, 1988). Neotropical migrants that are Alaskan or North American species of special conservation concern, including rusty blackbird (undergoing a steep, range-wide decline), blackpoll warbler, and olive-sided flycatcher, also migrate through and breed locally in the Kenai lowlands and other coastal areas (ADF&G, 2015; Greenberg, et al., 2011). Many species of raptors, all top predators, migrate through or breed near Cook Inlet (e.g., northern goshawk, osprey, great horned owl, and northern hawk-owl). Lower Cook Inlet supports large year-round concentrations of bald eagle where they feed on fish and countless other small vertebrates. Finally, thousands of sandhill crane migrate annually through lower Cook Inlet and many also breed in the low wetlands around the inlet.

The Important Bird and Biodiversity Areas (IBAs) Program was established by the National Audubon Society as a global effort to identify and conserve areas vital to birds and biodiversity (National Audubon Society, 2010; Smith et al., 2012). The 23 IBA sites designated along the coast, in nearshore waters, or offshore in Cook Inlet (Figure 4-4), are listed and described in Table 4-16. Kachemak Bay and the Fox River Flats in particular, with tides of as much as 9 m (30 ft), provide an abundance of intertidal habitat for the geese, ducks, swans, and over a million of 36 species of shorebirds that annually pause on the mudflats (ADF&G, 1993). Kachemak Bay is recognized as the second most important shorebird staging area in Alaska (following the Copper River Delta) (WHSRN, 2009).

Table 4-16: Important Bird Areas in or near the Proposed Lease Sale Area

IBA	Priority	Recognized Importance
1. Amakdedulia Cove	Continental	Seabird nesting colony; summer waterfowl congregation area.
2. Anchor River	State	Migratory passerine concentration area.
3. Barren Islands Colonies	Global	Seabird nesting colonies, supporting 14 species and more than 400,000 birds, e.g., pelagic cormorant, glaucous-winged gull, black-legged kittiwake, tufted puffin, and fork-tailed storm-petrel.
4. Clam Gulch	Global	Steller’s eider wintering area; black scoter, long-tailed duck, and common eider present.
5. Contact Point	State	Seabird nesting colony for 6 species; spring waterfowl congregation area.
6. Fox River Flats	Global	Spring migration stopover area for many shorebird species; spring, fall, and winter waterfowl congregation area.
7. Homer Spit	Global	Wintering area for Steller’s eider and other sea ducks, rock sandpiper
8. Kachemak Bay	Global	Seabird and sea duck wintering habitat; waterfowl and shorebird migration stopover habitat; and seabird foraging habitat.
9. Kamishak Bay	Global	molting habitat for Steller’s eider; breeding habitat for glaucous-winged gull
10.Kenai River Flats	Continental	Spring staging area for Wrangell Island snow goose; seabird nesting colonies; migrant shorebirds, waterfowl and sandhill crane also use the area.
11.Lower Cook Inlet 59°N, 153°W*	Global	Non-breeding habitat for glaucous-winged gull and other seabirds.
12.Redoubt Bay	Global	Supports large population of spring migrant shorebirds; waterfowl, including multiple species of ducks, geese, and swans.
13.Swanson Lakes	Global	Trumpeter swan; red-throated loon; one of highest densities of common loon in North America.
14.Trading Bay	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	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	Global	Seabird nesting colony hosting multiple species, including black-legged kittiwake. Shorebird migration stopover habitat for western sandpiper; waterfowl migration stopover habitat for Canadian geese; and waterfowl molting habitat for surf scoter and white-winged scoter.
17.Amalik Bay Colonies	Global	Seabird nesting colonies, hosting 10 species, including red-faced cormorant.
18.Northwest Afognak Island	Continental	Breeding area for black oystercatcher; nesting and foraging habitat for other shorebirds and seabirds.
19.Uganik Bay and Viekoda Bay	Global	Several seabird nesting colonies; breeding area for black oystercatcher and other shorebirds; wintering area for multiple species of seabirds and waterfowl.
20.Wide Bay	Global	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	Continental	Spring and fall stopover for waterfowl.
22.Palmer Hay Flats	State	Spring and fall stopover area for waterfowl.
23.Susitna Flats	Global	Spring migration stopover area for waterfowl and shorebirds; critical rock sandpiper (nominate race) wintering area.

Source: Audubon Alaska, 2014.



Notes: See Table 4-16 for key to IBA names and further information.

Source: Audubon Alaska, 2014.

Figure 4-4: Important Bird and Biodiversity Areas in and around the Proposed Lease Sale Area

4.7.2 Environmental Consequences of the Proposed Action

4.7.2.1 Noise

Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, which could cause noise impacts to birds include seismic surveys (deep penetrating and geohazard surveys). During the course of normal feeding or escape behavior, some diving seabirds, sea ducks, or loons could be injured or disturbed by underwater airgun noise (Turnpenny and Nedwell, 1994). Many of these waterbirds routinely dive to 10 or more meters in depth and can spend more of their foraging time submerged than on the surface. During the seismic surveys, a few foraging birds or flightless molters that dive in alarm from the survey vessel could forage at depths near enough to firing airguns that they receive a pulse strong enough to cause injury (Brown and Adams, 1983). More typically, the effect on birds would be displacement either when they detect underwater surveys or in response to localized seismic sound-caused changes in prey availability (Section 4.6; Pichegru et al., 2017; Leopold and Camphuysen, 2009). Effects on birds would be localized and brief around the survey vessels that are continually moving toward new areas. Brief displacement for some birds in overall abundant populations would have only short-term, and no population level, effects.

4.7.2.2 Habitat Alteration

Post-lease activities described in the E&D Scenario could alter marine and terrestrial habitats of birds, ultimately impacting birds themselves. Activities that would potentially cause marine habitat alteration impacts include anchoring of drilling units and vessels, platform and pipeline installation, and discharge of drill cuttings in the marine environment. Onshore pipeline construction would cause terrestrial habitat impacts.

Marine habitat where diving birds would be potentially affected includes both benthic and water column foraging areas. Pipeline trenching and platform installation, anchor chain sway from vessels or exploration drilling units (MODUs), and discharge of drilling fluids and cuttings would disturb or cover several localized areas of benthic habitat and any invertebrate prey present. Most of these activities may occur year-round, so benthic-feeding birds may be affected while breeding (e.g., long-tailed duck), molting (e.g., Steller’s eider, scoter species), or wintering (e.g., Steller’s eider, scoter species).

Benthic impacts from post-lease activities described in the E&D Scenario would, however, occur primarily offshore and be limited to the footprint of construction, trenching, and vessel anchoring. Most of this activity would be outside the habitat of molting Steller’s eider and other sensitive waterfowl on the west side of lower Cook Inlet. Finally, benthic impacts are expected to be typically short-term and localized for invertebrate prey (Section 4.6). For these reasons, benthic habitat impacts to birds are also expected to be generally no more than short-term and localized.

Marine activities that increase turbidity in the water column could affect some pelagic birds by reducing their ability to visually forage or by temporarily decreasing abundance of invertebrate and fish prey. Such activities include anchoring, pipeline trenching, and drilling discharges; the latter two limited to the few exploration and construction years. Levels of impact would vary with locations and season. Vulnerable bird populations could be further stressed by a loss of foraging efficiency if it occurred over a few days of repeated elevated turbidity in a preferred area. For example, multiple lower Cook Inlet colonies of water column-foraging murres and black-legged kittiwakes have had mass breeding failures linked to starvation stress and marine heatwaves during a few recent years, and repeated failures could lead to long-term effects (Section 4.7.1; Piatt et al., 2020). Declining red-throated loons are another vulnerable species that forages in the water column. In general, however, the level of impact to birds would be no more than short-term and localized, similar to invertebrate and fish prey resources (Section 4.6.2).

Terrestrial pipeline construction could impact birds through loss of staging or breeding habitat, or by direct mortality. Depending on location and season, construction activities could disrupt time-sensitive foraging during spring and fall staging of waterfowl, shorebirds, and cranes when birds from widespread breeding populations are concentrated in lower Cook Inlet coastal areas. Birds that would permanently or temporarily lose some nesting habitat from pipeline construction include many species of landbirds, waterfowl, shorebirds and raptors, and sandhill crane. Densities of diverse breeding birds in southcentral Alaska are such that loss of a few hundred acres of nesting habitat would typically impact hundreds or thousands of birds until some habitat, potentially of lesser quality for some of them, was restored (Matsuoka et al., 2001; Manning and Cooper, 2004). Most nests are camouflaged on the ground or in low vegetation, and many birds such as sparrows and warblers are so small and secretive as to be overlooked while nesting. If land clearing was conducted during spring or summer, destruction of a few hundred active nests, eggs, or flightless chicks would be expected. Most local populations are robust enough to incur no more than short-term, i.e., single season, impacts from this level of loss. Depending on timing and location of activities, however, some migratory birds that are declining or otherwise vulnerable (e.g., rusty blackbird, sandhill crane) could experience long-term effects to breeding or staging populations.

To mitigate terrestrial habitat impacts, onshore and shoreline pipeline siting and associated construction activities could potentially be avoided in critically important habitat areas, especially estuarine and salt marshes and coastal IBAs. Also, avoiding land clearing during the peak local breeding season (April 20 through July 15) would minimize unnecessary destruction of active nests, eggs, and flightless chicks (USFWS, 2020). If these mitigation measures were both applied, bird habitat impacts would be no more than short-term and localized for all species.

4.7.2.3 Disturbance

Post-lease activities described in the E&D Scenario would produce disturbance impacts (up to and including mortality) to lower Cook Inlet birds via vessel, aircraft, and vehicle operations, as described below.

The bright artificial lighting of vessels, MODUs and production platforms, and gas flaring from the latter, can, under certain environmental conditions, attract and disorient migrating birds. These lit objects on the otherwise dark and featureless sea then become collision hazards to some birds during migration (Day et al., 2005b; Ronconi et al., 2015; Montevecchi et al., 1999). Many species are known to be disoriented by lights and gas flaring, and ultimately collide with ships and platforms in Alaska, especially under conditions of poor visibility like fog, precipitation, and darkness (Day et al., 2015; Greer et al., 2010). At-risk birds include those that are nocturnally migrating or otherwise nocturnally active, like passerines and many seabirds (Bruinzeel et al., 2009; Merkel and Johansen, 2011).

Because birds are known to commonly collide with vessels in Alaska, they would be expected to collide with seismic survey and support vessels, MODUs, and production platforms associated with activities resulting from LS 258 as described in the E&D Scenario. Many types of birds experience these collisions including gulls, fulmars, shearwaters, storm petrels, jaegers, eiders, phalaropes, other shorebirds, and many species of passerines (BOEM, 2020; Day et al., 2017; Greer et al., 2010; USFWS, 2012). Flocks of eiders also have a history of colliding with ships in Alaska, and the low, fast-flying Steller’s eider may be especially vulnerable (NOAA, 2020; USFWS, 2012). Up to hundreds of bird collisions would be expected to be observed annually throughout the decades of the E&D Scenario (BOEM, 2020; USFWS, 2012). For this analysis, all collisions are assumed to be fatal. Most are likely to occur during migration but strikes of locally breeding and wintering birds would be expected as well. Several fatalities may be incurred from a single breeding population, but most would be expected to be from birds that move through together on migration from disparate, widespread breeding populations. All would be breeding-age adults, the chronic loss of which could potentially have long-term consequences for a few vulnerable or declining populations. If a mitigation protocol of reduced and shielded lighting, monitoring, and adaptive management were implemented, fewer collisions and a lowered chance of chronic loss of vulnerable-population birds would be expected. Collisions would still occur, however, and collision impacts would still range from localized to potentially widespread. The proposed monitoring and lighting measures are explained below and further detailed in Section 3.4.

A lighting plan and operating protocol that includes lighting (and flaring) design and control, collision monitoring, and adaptive management is commonly recognized as an appropriate strategy for tracking and reducing bird collisions, particularly on drilling units and platforms. Mitigation protocols from prior Alaskan lease sales have included changes to light direction and shading, where safe and feasible, to reduce disorientation of passing birds (BOEM, 2015a). Light directed inward and downward, for example, is believed to be less disorienting to birds than lighting schemes that radiate outward and upward, and platforms have also been fitted with bird-repellant lighting schemes (Ronconi et al., 2015; Miles et al., 2010; Day et al., 2017). Comprehensive monitoring, following scientifically approved protocols, of collisions and ultimate fates of grounded birds, improves assessments of the site-specific factors that may cause attraction (Wiese et al., 2001; Ellis et al., 2013). The as-needed implementation of adaptive management could be aimed at further reducing the risk of collision. It may be possible to implement a change in lighting operations if real-time monitoring reveals the occurrence of heavy migration and strike risk or that, for example, a specific light source is causing multiple strikes.

Besides being potential sources of underwater noise and in-flight collisions, the operation of vessels could disturb birds at sea. Individual and flocks of birds generally move away from vessel activity. Many species, including flight-capable eiders and scoters, typically take flight to avoid a fast-approaching vessel, and flightless (molting) birds at sea remain capable of paddling away from disturbances (Hentze, 2006; Petersen et al., 2006; Schwemmer et al., 2011). Readiness to flush (fly or swim away from disturbance) may vary according to many things including species, vessel speed, sea state, and how successful a bird has already been that day at foraging (Hentze, 2006; Weber, 2014). Many birds would return quickly; some murrelets, sea ducks and loons, however, could be displaced from preferred foraging habitats for 6–8 hours or more (Agness et al., 2008; Lacroix et al., 2003; Schwemmer et al., 2011). Flushing of breeding and non-breeding birds while foraging or resting can have fitness impacts, i.e., on reproductive success and survivorship (Agness et al., 2013).

Over 40 vessel trips per week could occur during open water months of the few years of heaviest activity when development (i.e., platform installation) and production overlap (Table 4-4 and Figure 4-3). Typically, however, vessel activity levels would be much less, and most trip miles would be confined to roughly straight routes from Kenai or Homer. Most exposed birds would experience a one-time vessel disturbance, potentially a brief displacement from foraging, and would quickly recover without measurable impacts as vessels moved out of the area. Flocks of white-winged scoters and other sea ducks that winter in groups in nearshore habitat between Kenai and Kachemak Bay would be the most vulnerable. Wintering Steller's eiders could be among those sea ducks experiencing longer-term impacts to their population if disturbance stressed their already small and potentially declining numbers. If murres or other seabirds are experiencing a year of extreme starvation and low or no productivity, as has been the case in some recent years, their numbers or fitness levels could be so low that they cannot quickly recover from vessel disturbance. Flushing of dense seabird colonies by vessels (or aircraft) can result in mass loss of eggs and chicks inadvertently kicked into the sea or left unprotected from predators, substantially impacting a colony's reproductive success. Such flushing and colony failure is expected to be avoided, however, with proposed requirements for all traffic to observe a buffer area around seabird colonies (Section 3.4), as well as existing practices and guidance including FAA guidance to maintain an altitude of at least 610 m (2,000 ft) when flying over sensitive areas such as national parks, wildlife refuges, and wilderness areas.

Air traffic disturbs some birds, primarily waterbirds, in coastal and pelagic areas. Komenda-Zehnder et al., (2003) found that disturbance effect of helicopters is typically greater than that of fixed-wing aircraft and increases with decreasing flight altitude. They found that flushing, at least for non-nesting birds, is greatly reduced when fixed-wing aircraft are above 300 m (984 ft) and helicopters above 450 m (1,476 ft). Seabirds do not necessarily habituate, but often return quickly to foraging or other interrupted behavior (Komenda-Zehnder et al., 2003; Mallory, 2016). The greatest numbers of impacted birds would include those that are particularly concentrated for migration staging, molting, or in breeding colonies.

Productivity of some densely nesting seabird species can be affected, as noted in the above discussion of potential vessel disturbance, if flushing occurs early in the nesting cycle or if opportunistic predators like eagles are present.

Aircraft associated with the E&D Scenario activities would fly year-round from Kenai and Homer, so populations vulnerable to disturbance include spring staging waterfowl and shorebirds at the Kenai River Flats and Kachemak Bay, wintering Steller's eider and other sea ducks at Clam Gulch and Kachemak Bay, and nesting seabirds at dense colonies in Kachemak Bay and the Kenai River Flats. Staging and migrating birds turn over often in coastal areas, however, and individuals are unlikely to be repeatedly displaced from preferred coastal habitat. In summary, with overflights expected to be brief, large overall populations, and colony buffer zones, aircraft effects on most breeding birds would be limited to short-term foraging or resting disturbance in the immediate area. Seabird colonies are typically avoided by pilots, and standard minimum buffer zones of 610 m (2,000 ft) above ground level are expected (FAA/AIM, 2019; Denny and Hobi, 2017). (This minimum flight altitude necessary to protect colonies is greater than the 1,500 ft typically required to avoid disturbance to marine mammals.)

Increased ground traffic on existing roads in support of E&D Scenario activities is expected year-round in terrestrial environments. In summer, this may have the effect of killing a small number of brooding hens and flightless chicks of waterfowl and shorebirds crossing roads. Vehicle traffic would also occasionally impact natural movement patterns of some broods, including preventing access to preferred foraging habitats and shelter from predators. Numbers of affected birds of any given species would be low enough that no more than short-term and localized impacts to any population would result.

4.7.2.4 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on birds are described in Section A-3.5 of Appendix A. Most accidental spills would be localized and limited in area. A large spill that contacts many marine birds or reaches coastal areas would have impacts that are more persistent, require remediation, and impact a greater number of birds and species. If it occurred during a period of high bird use in coastal waters, it would be expected to foul large numbers of staging and migrating birds from widespread populations. Foraging, resting, and sheltering habitat for staging, migrating, and nesting birds would be fouled, with mechanical damage to foraging habitat and possibly nests during the cleanup process. Some populations that experience spill-related effects to large numbers of birds would be expected to take several years to recover. Long-term damage to otherwise vulnerable seabird breeding populations (e.g., chronically failing murres and black-legged kittiwakes) would be possible. The long-term and widespread impacts from a large spill would not be categorized as severe for most species because the various populations affected would be expected to eventually recover. Depending on location and timing, however, contact with wintering rock sandpipers or their habitat would have potentially severe population level impacts. Spill drills are localized and limited in time and place and would have little effect on birds. Spill response would typically have short-term and localized displacement-related impacts, but impacts would range up to long-term if involving both marine- and land-based activities when large concentrations of birds are present or nesting. In the unlikely event that migrating or staging birds were within the vicinity of a gas explosion, a few hundred individuals from disparate populations could be killed, which would have a localized level of impact.

4.7.2.5 Conclusion

Most lower Cook Inlet birds would experience no more than short-term and localized, i.e., minor, impacts from any activity or combination of activities, accidental small spills, and spill drills described in the E&D Scenario. For example, marine birds would typically be expected to experience little effect from one-time displacements associated with underwater noise, marine habitat alterations, and vessel and aircraft operations, and most populations would not be affected by a few collisions. In most cases, individual birds and populations would be exposed to no more than one or two instances of the activities considered in the E&D Scenario, and different birds would be exposed to different impacts so the impacts would not be additive. A few vulnerable or declining populations could experience long-term and/or widespread, i.e., moderate, impacts from E&D Scenario activities. In particular: a) vessel operations or marine habitat alterations could displace birds or interfere with foraging, and starvation-stressed murres or other weakened waterbird populations could experience impacts lasting beyond a single season, and b) the bright artificial lighting or gas flaring from vessels and platforms could cause collisions of migrating birds from widespread populations at a rate of collisions that certain vulnerable populations may find difficult to withstand without long-term impacts. The long-term presence of vessels and platforms means that these hazards would be on-going, and the rate of impact could eventually have long-lasting effects on a few vulnerable, declining, or sensitive populations. Also, some local nesting populations would potentially have long-term consequences from terrestrial pipeline construction, if not reduced to short-term by proposed timing and site-selection mitigation measures. No more than a few populations of any one species would be affected, so the overall impact level from activities described in the E&D Scenario would not rise to the level of "severe" (i.e., "major"). When considering the effects of a large spill and related response efforts added to the activities described in the E&D Scenario, there would still be a range of impact level that depends on species and populations involved. The overall impact level would be minor to major with the addition of a large spill and related response, however, because a much greater and widespread group of species could experience long-term impacts.

4.7.3 Environmental Consequences of the Alternatives

4.7.3.1 Alternative 3A – Beluga Whale Critical Habitat Exclusion

Alternative 3A excludes 10 of the 224 OCS blocks offered under the Proposed Action. The exclusion is small enough that it would not change the overall level of impact to birds in the Proposed Lease Sale Area. The impact level would remain small, localized, and therefore minor, for most birds. However, the exclusion proposed in Alternative 3A would result in somewhat fewer individual impacts. In particular, impacts to marine birds present in the exclusion area would be eliminated. Those marine birds would typically include several types of wintering marine birds, and, in the summer, breeding Kittlitz's murrelet and colonial breeding seabirds from the large colonies at Chisik Island and Tuxedni Bay. Most of these birds likely range beyond the exclusion area and also use habitat to the south in OCS lease blocks still offered under Alternative 3A. Many of them, including the Chisik Island colonies, have also recently experienced multiple breeding failures and die-offs however, and so any lessening of impacts may be considered beneficial to these vulnerable birds (Arimitsu, Schoen et al., 2019; Piatt and Roseneau, 1997). Effects to marine birds from E&D Scenario activities, including accidental small spills and spill drills, would still be minor for most populations, with potentially fewer vulnerable populations at risk of moderate impacts as a result of the Alternative 3A exclusion. When also considering a large spill and spill response, the overall level of impact for Alternative 3A would be moderate (i.e., essentially the same as that of the Proposed Action) because of the larger and more widespread groups of birds experiencing long-term impacts from a hypothetical large spill.

4.7.3.2 Alternative 3B – Beluga Whale Critical Habitat Mitigation

Alternative 3B, prohibiting seismic surveys and exploration drilling activities in the 10 northernmost OCS lease blocks of the Proposed Lease Sale Area from November 1 to April 1, is unlikely to result in a measurably different level of effect than the Proposed Action. This is because only wintering birds, not the colonies in the area, could experience a reduction in anticipated impacts, and only during a few of the E&D Scenario years. Lower Cook Inlet is important wintering habitat for many marine birds, but in winter their foraging range may be larger, more plastic, and not determined by distance from the breeding site (Meehan, et al., 2019; Ashmole, 1963; Jovani et al., 2016; Ballance et al., 1997). Under Alternative 3B, wintering birds would only avoid impacts in a limited area of their foraging range, and only for those years in which seismic survey and exploratory drilling take place. The overall impact level from E&D Scenario activities including accidental small spills and spill drills would therefore be essentially the same as that of the Proposed Action — a range of minor to moderate for the various populations. When also considering a large spill and spill response, the overall level of impact for 3B would be essentially the same as that of the Proposed Action — moderate.

4.7.3.3 Alternative 3C – Beluga Whale Nearshore Feeding Areas Mitigation

Wintering marine birds would be spared underwater noise, vessel disturbance, and collision risk for a year if no on-lease seismic surveys occurred on any OCS lease blocks in the Proposed Lease Sale Area between November 1 and April 1. If seismic surveys were additionally excluded between July 1 and September 30 in the zone within 10 mi of anadromous streams, those marine birds that forage in the area during much of the breeding season would also be spared seismic survey injury and disturbance risks for the few years in which seismic surveys take place. Under Alternative 3C, seismic surveys would still be allowed October 1–31 and April 1–June 30, however, and both of those are critical time periods for many lower Cook Inlet marine birds. In particular, May and June are critical times for seabirds and sea ducks preparing to nest, and molting sea ducks including Steller's eider and mergansers would still be present in abundance in October in the west Cook Inlet habitat they depend on (Larned, 2006). In summary, there would potentially be fewer negative effects on birds relative to the Proposed Action, but the overall impact level would be essentially the same — minor to moderate for E&D Scenario activities, including accidental small spills and spill drills. When adding the effects of a large spill and spill response, the overall level of impact for 3C would be essentially the same as that of the Proposed Action and the other Beluga Whale Mitigation Alternatives — moderate.

4.7.3.4 Alternative 4A – Northern Sea Otter Critical Habitat Exclusion

Alternative 4A would eliminate all E&D Scenario impacts for marine birds while they are foraging in the 7 OCS blocks that overlap with northern sea otter critical habitat. This would include breeding and non-breeding seabirds in summer and winter, but no measurable protections for any particular sizeable colony. The reduction in affected foraging area for the entire period of the E&D Scenario would mean somewhat less impact for these birds, but foraging range for many of these frequently food-stressed birds likely extends into the surrounding OCS blocks available for lease where they could still be measurably impacted. The overall level of effect would be a similar range as that of the Proposed Action (i.e., mostly short-term and minor, with some vulnerable populations potentially experiencing long-term and moderate impacts). When adding the effects of a large spill and spill response, the overall level of impact for Alternative 4A would be essentially the same as that of the Proposed Action — moderate.

4.7.3.5 Alternative 4B – Northern Sea Otter Critical Habitat Mitigation

Alternative 4B considers mitigation in 14 OCS lease blocks spread out at various sites along the western lower Cook Inlet Planning Area boundary. Under this alternative, which prohibits seafloor disturbance and discharge of drilling fluids and cuttings in the 14 lease blocks, there would be fewer impacts than the Proposed Action for birds breeding from Kamishak Bay to Tuxedni Bay, and sea ducks that depend on a footprint similar to the Northern Sea Otter SW DPS Critical Habitat Area. Birds in these areas have particular sensitivities, as reflected by, for example, the importance of Kamishak Bay to benthic-feeding birds like molting Steller's eider and molting and wintering scoters, and recent Kamishak Bay die-offs of adult birds (e.g., shearwaters, storm petrels, fulmars, and murres) (USFWS, 2018; Renner et al., 2017). Because of the importance of these sites to an abundance of birds, and because the waterfowl are benthic foragers, an alternative that protects seafloor habitat here would mean fewer impacts to birds relative to the Proposed Action. Affected birds, however, likely range beyond the relatively small areas of the OCS mitigation blocks and therefore would be subject to impacts from the activities described in the E&D Scenario for at least part of each season. Therefore, the overall impact level would be a similar range as that of the Proposed Action (i.e., mostly short-term and minor, with some vulnerable populations potentially experiencing long-term and moderate impacts). When adding the effects of a large spill and spill response, the overall level of impact for 4B would be essentially the same as that of the Proposed Action — moderate.

4.7.3.6 Alternative 5 – Gillnet Fishery Mitigation

This alternative would avoid impacts to foraging breeding marine birds and non-breeding shearwaters during the summer, but only those impacts resulting from seismic surveys. While impacts would therefore be a bit fewer, the overall impact level for birds would not differ substantially from those described for the Proposed Action — minor to moderate for E&D Scenario activities, accidental small spills, and spill drills. When adding the effects of a large spill and spill response, the overall level of impact for Alternative 5 would be essentially the same as that of the Proposed Action — moderate.

4.7.4 Cumulative Effects

Birds using lower Cook Inlet have been or will be affected by past, present, and RFFAs including oil and gas and renewable energy operations, traffic, mining, commercial fishing, community development, and military activities. Many birds are also affected by climate change, as discussed below, and the lingering effects of the 1989 EVOS have contributed to the lack of recovery of lower Cook Inlet pigeon guillemot and common murre numbers (Esler et al., 2018). (Other impacts and stressors are incurred by lower Cook Inlet birds, most of which are migratory, on other continents or oceans, but those details are outside the scope of this analysis.) The array of relevant cumulative impacts to birds in lower Cook Inlet include disturbance and displacement; habitat loss; light attraction and collision risk; and decreased fitness, survivorship, and reproduction from contaminants and oil spills. Because of the wide variety of bird types and habitat uses, most birds and bird populations experience no more than a single type of effect from the E&D Scenario activities or other past, present, and RFFAs. This means that cumulative effects on birds are not typically additive, except with climate change-related impacts which potentially affect most birds.

The impact on birds of past, present, and reasonably foreseeable future oil and gas activities in lower Cook Inlet are similar in type, but typically collectively larger in geographic and/or temporal scope, than the impacts of analogous activities related to LS 258 and as analyzed in Section 4.7.2. This is particularly true for traffic disturbance and habitat-related impacts. In a few localized offshore areas with little other traffic, vessel and aircraft traffic described in the E&D Scenario may be the dominant source of some short-term impacts, but they would be only a small increment of the cumulative impacts expected to be experienced by all lower Cook Inlet birds. Habitat loss from other past, present, and reasonably foreseeable future oil and gas activities have or will have effects similar to those described above in relation to E&D Scenario activities. Cumulative habitat loss primarily affects birds that are staging and migrating, and cumulative habitat losses are and would be relatively small compared to unimpacted habitat still available to most lower Cook Inlet birds. Habitat losses are composed of an array of localized alterations that would not result in population level effects for most birds. Some declining or otherwise vulnerable birds could experience long-term effects from cumulative noise, traffic disturbance, and habitat alterations.

Current impacts from oil and gas and renewable energy activities in Cook Inlet include migratory bird light attraction and collision hazards from the existing 11-turbine Fire Island wind farm, 18 lighted production platforms, and platform-associated vessel traffic in Cook Inlet state waters. Many of the same birds would be at risk from the incremental addition of a maximum 6 platforms resulting from LS 258 post-lease activity (described in the E&D Scenario) to the south of the existing turbines and platforms, because all of Cook Inlet is a single important migration corridor for many birds, especially northward-bound migrants in the spring (Day et al., 2005a). Cumulatively, the collision risk of all oil and gas and renewable energy activity would be ongoing and long-term due to the long-term nature of the installed facilities. The incremental addition of LS 258-related platforms would, however, increase the cumulative size of the risk area because they would be the first long-term light attraction hazards in lower Cook Inlet's currently featureless waters. Numbers of avian collisions would increase with increasing numbers of platforms and associated vessel activity. Also, some vulnerable species do have substantially more of their migratory pathway (or exposure risk) area in the vicinity of the Proposed Lease Sale Area than in upper Cook Inlet. These vulnerable species include a rare marbled godwit subpopulation (*Limosa fedoa* *beringiae*) which is believed to fly across central and lower Cook Inlet from its only breeding ground on the Alaska Peninsula south to wintering areas in the contiguous United States. Also, most other past, present, and reasonably foreseeable future platforms and the Fire Island Wind Project are, unlike the Proposed Lease Sale Area, outside of the normal wintering range of the Steller's eider. Steller's eiders that winter in Kodiak may be particularly at risk from the incremental addition of LS 258-related platforms because these birds likely migrate across lower Cook Inlet from Kodiak to southwest Alaska (ADF&G, 2015; Rosenberg et al., 2014). In summary, the incremental addition of LS 258-related platforms is expected to measurably and substantially increase the cumulative light attraction and collision risk for birds.

The types of impacts related to a large oil spill and related spill response on birds are discussed in Section A-3.5 of Appendix A. Appendix A also considers the possibility of up to two additional potential large spills from sources other than those related to LS 258 post-lease activity. If those spills are also considered, the impacts to birds, their habitats, and prey could be long-lasting over years but are unlikely to overlap in space and time with each other. Increased numbers of spills would, however, increase the chances of impact to a large breeding colony or stopover site during migration. If a large spill and associated response were to occur at such a place and time, large numbers of birds would be affected, their habitat would incur long-term impacts, and birds at migration stopovers that are gathered from many different breeding populations (i.e., from a widespread area) could be affected.

Cook Inlet birds have been impacted in large part by past, present, and RFFAs unrelated to the energy industry. The planned Donlin Gold mine natural gas pipeline would have habitat loss, and disturbance and displacement effects on birds using the west side of Cook Inlet (USACE, 2018). The Diamond Point Rock Quarry would have habitat and disturbance impacts from dredging and traffic, also on the west side of Cook Inlet. Commercial fisheries impact lower Cook Inlet seabirds through ongoing gillnet bycatch and occasional light attraction and collision (Carter et al., 1995; USFWS, 2006; Piatt et al., 2007; NOAA, 2020). Community development has resulted in proportionally greater habitat loss than energy-industry activities, particularly in upper Cook Inlet and on the east side of lower Cook Inlet (North, 2001). Past, present, and reasonably foreseeable future military aircraft collisions have caused and will continue to risk loss of human and bird life. Military activities also have unique contributions to cumulative effects in the form of past and potential future poisoning, via spent munitions, of thousands of migrating waterfowl stopping at Eagle River Flats in upper Cook Inlet (85 FR 14928, March 16, 2020; Racine, et al., 1992; EPA, 2008).

Climate change and past and predicted ecosystem regime shifts are anticipated to be the largest source of impacts to birds in lower Cook Inlet in the coming decades (Cushing et al., 2018; Anderson and Piatt, 1999). Seabirds, which are high trophic level organisms with complex seasonal and other life history requirements, are anticipated to demonstrate high sensitivity to climate change (Urban et al., 2017; Van der Putten et al., 2010). Population regulation is strongly influenced by food supply for Alaska seabirds, and foraging-related impacts are among those effects observed and anticipated (Goyert et al., 2018). For example, the magnitude of a recent common murre die-off in the GOA (and lower Cook Inlet) is unprecedented—even larger than that caused by the EVOS—and the immediate cause of mortality was starvation (Piatt et al., 2020). This event was one of multiple die-offs and breeding failures of both locally breeding (e.g., murres and kittiwakes) and wintering (shearwaters) seabirds that have occurred in the GOA in the last few years (NPS, 2019). Recent studies show that these events are linked to large-scale, complex ecosystem processes including increases in sea surface temperatures and decreasing availability of high-energy content forage fish, and that these events are likely to continue (Section 4.6; Piatt et al., 2020; von Biela et al., 2019). Climate change impacts birds in other ways besides through seabird foraging. For example, increases in rain and storms would increase impacts to nests of seabirds, raptors, and landbirds via erosion, flooding, and exposure. Drying of freshwater habitats is expected to adversely affect species such as the rusty blackbird which depend on these as breeding habitats. In the Cook Inlet area, the cumulative impacts of climate change on birds will vary somewhat depending on species but are expected to be long-lasting and widespread for many.

Overall, the cumulative impact to birds from past, present, and RFFAs, and a changing climate, including the incremental activities resulting from post-lease LS 258 activities as described in the E&D Scenario, would be moderate, with a few populations potentially incurring severe or major impacts. Complex, climate-related changes are expected to have the most widespread and long-term contribution of impacts on many species. Some populations will likely experience ongoing and synergistic effects from climate-related impacts and repeated or annual exposure to a suite of factors such as collisions and other disturbances, and habitat loss. Declining and limited populations are expected to persist but ultimately may be so affected by climate change and, potentially in some cases, large spills, and associated spill response that they would experience major impacts. For one or two vulnerable populations particularly at risk from offshore collisions in lower Cook Inlet, such as the marbled godwit subpopulation and Steller's eider, the installation of offshore structures and vessel activity described in the E&D Scenario could actually pose a relatively large proportion of the cumulative offshore collision risk, potentially changing their impact risk level from moderate to major. For most birds, however, post-lease activities that occur as a result of LS 258 are not expected to contribute measurably to the moderate to major cumulative impacts.

4.8 Marine Mammals

4.8.1 Affected Environment

Marine mammals most likely to be present in the Proposed Lease Sale Area are beluga, killer, fin, gray, humpback, and minke whales; Dall's and harbor porpoises; Pacific white-sided dolphins; harbor seals; Steller sea lions; and sea otters (Table 4-17). Species such as blue, sei, sperm, and beaked whales; northern fur seals, and elephant seals were considered, but excluded from analysis because they are rare or uncommon in the Proposed Lease Sale Area.

4.8.1.1 Whales and Porpoises

Cook Inlet beluga whales are white, toothed whales found in upper Cook Inlet when sea ice is absent, and farther south into lower Cook Inlet after sea ice formation. During spawning runs of anadromous fishes, they congregate near the mouths of larger streams to feed, particularly salmon and smelt. Satellite data from tagged whales suggest some belugas feed in deeper waters south of the Forelands during winter (Hobbs et al., 2005). They have broad diets that include fish such as salmon, cod, smelt, eulachon, and flounder; and crustaceans and cephalopods (Quakenbush et al., 2015; Saupe et al., 2014; Fall et al., 1984; Huntington, 2000; Hobbs et al., 2005). A recent study suggests Cook Inlet beluga whale reproductive success is tied to king salmon abundance in the Deshka River (Norman et al., 2020). Calving and breeding primarily occur between mid-May and mid-July in the upper inlet (NMFS, 2008c). The beluga population estimate dropped precipitously in the 1990s because of overhunting by subsistence practitioners, leading to their designation as endangered under the ESA in 2008 (73 FR 62919, October 22, 2008; 76 FR 20189, April 11, 2011; Muto et al., 2020); subsistence hunting was voluntarily suspended in 1999. However, the Cook Inlet population has continued decreasing to an estimated 279 individuals, despite ESA and MMPA protections (Gill 2020; NMFS 2016; Muto et al. 2020).

Table 4-17: Marine Mammals Occurring in Cook Inlet, Alaska

Common Name	Status ESA (MMPA)	Seasonal Presence in Cook Inlet	Estimated Hearing Range	Minimum Abundance Estimate
Beluga Whale (Cook Inlet Stock)	Endangered (Depleted)	Year-long	150 Hz – 160 kHz[f]	279[e]
Resident Killer Whale (Alaska Resident Stock)	N/A (Not Depleted)	Year-long in ice free waters	150 Hz – 160 kHz[f]	2,347[b]
Biggs Killer Whale (Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock)	N/A (Not Depleted)	Year-long in ice-free waters	150 Hz – 160 kHz[f]	587[b]
Fin Whale (Northeast Pacific Stock)	Endangered (Depleted)	Spring, Summer, and Fall in lower inlet	7 Hz – 35 kHz[f]	2,554[a]
Gray Whale (Eastern Pacific Stock)	N/A (Not Depleted)	Spring and Fall in lower inlet	7 Hz – 35 kHz[f]	25,849[c, d]
Humpback Whale (Central and Western North Pacific Stocks)	Endangered (Depleted) Endangered (Depleted)	Spring, Summer, and Fall in lower inlet	7 Hz – 35 kHz[f]	2,222[b] 865[a]
Minke Whale	N/A (Not Depleted)	Spring, Summer, and Fall in lower inlet	7 Hz – 35 kHz[f]	UNK[a, b]
Dall's Porpoise (Alaska Stock)	N/A (Not Depleted)	Year long	275 Hz – 160 kHz[f]	UNK[a, b]
Harbor Porpoise (Gulf of Alaska Stock)	N/A (Not Depleted)	Year-long in lower inlet. Ice-free season in upper inlet.	275 Hz – 160 kHz[f]	26,064[a]
Pacific White-sided Dolphin	N/A (Not Depleted)	Year-long in lower inlet	275 Hz – 160 kHz[f]	26,880[b]
Harbor Seal (Cook Inlet/Shelikof Strait Stock)	N/A (Not Depleted)	Year-long in lower inlet. Ice-free season in upper inlet.	50 Hz – 86 kHz[f] (in-water)	26,907[a]
Steller Sea Lion (Western DPS)	Endangered (Depleted)	Year-long in lower inlet. Ice-free season in upper inlet.	60 Hz – 39 kHz[f] (in-water)	53,624[a]
Northern Sea Otter (Southcentral Alaska Stock, and Southwestern Alaska Stock)	Southcentral Stock N/A (Not Depleted) ------------------ Southwestern Stock Threatened (Depleted)	Lower Inlet. Southcentral AK Stock in Eastern Inlet waters and Southwestern Alaska Stock in Western Inlet waters.	60 Hz – 39 kHz[f]	14,661[b] 45,064[b]

Notes: ESA = Endangered Species Act MMPA = Marine Mammal Protection Act Hz = hertz kHz = kilohertz
[a] 2019 Alaska Stock Assessment
[b] 2018 Alaska Stock Assessment
[c] 2019 Pacific Stock Assessment
[d] 2018 Pacific Stock Assessment
[e] Gill, Verena. 2020. Cook Inlet Beluga Whale Management, Research, and Partnership Opportunities Workshop. 2020 Alaska Marine Science Symposium, Anchorage, AK.
[f] NMFS, 2018.Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing.

Two areas consisting of 7,809 km^2 (3,016 mi^2) of marine and estuarine environments were designated as Cook Inlet beluga whale Critical Habitat by NMFS (76 FR 20180, April 11, 2011) (Figure 2-2) and are essential to the survival and recovery of the Cook Inlet beluga whales. Area 1 of the Cook Inlet beluga whale critical habitat encompasses all marine waters of Cook Inlet north of a line connecting Point Possession and the mouth of Three Mile Creek. This area is not within the Proposed Lease Sale Area but provides important habitat during ice-free months and is used intensively by Cook Inlet beluga between April and November. Critical Habitat Area 2 includes marine waters of Cook Inlet south of Critical Habitat Area 1 to the mouth of the Douglas River; Kachemak Bay east of 151°40.0′ W.; and waters of the Kenai River downstream of the Warren Ames bridge at Kenai, Alaska. Some of this critical habitat occurs in the Proposed Lease Sale Area.

Two species of killer whales are present in lower and upper Cook Inlet on a regular basis. They are the resident killer whales and the Bigg's (transient) killer whales, both of which are black and white, toothed whales, with differences in diet, appearance, and behavior. Resident killer whales preferentially eat salmonids (particularly Chinooks), sablefish, herring, halibut, and cod, and other large fishes (Matkin et al., 2010; ADF&G, 2020c). Bigg's (transient) killer whales hunt and consume other marine mammals such as belugas, baleen whales, sea otters, porpoises, harbor seals, and Steller sea lions (Shelden et al., 2003; Saulitis et al., 2015; ADF&G, 2020c).

Fin whales are baleen whales that have been observed throughout the year in the Proposed Lease Sale Area as noted in decades of direct and indirect studies, and the areas around Kodiak. The Barren and Semidi islands and lower Cook Inlet are recognized as important feeding areas for them, especially during summer (Zerbini et al., 2006; Mizroch et al., 2009; Ferguson et al., 2015). During summer, fin whales feed on krill, small schooling fish (e.g., herring, capelin, and sand lance), and squid (https://www.fisheries.noaa.gov/species-directory; Mizroch et al., 2009).

In summer, humpback whales are regularly present and feeding in Cook Inlet and adjacent waters, and many remain in or near Cook Inlet through the end of autumn (Muto et al., 2019; ADF&G, 2020c). Humpbacks are baleen whales that typically feed on small schooling fishes, euphausiids, and other large zooplankton.

Minke whales are baleen whales that have been observed off Cape Starichkof and Anchor Point year-round, with some becoming sedentary, occupying localized feeding ranges (Dorsey, 1981; BOEM, 2015b; Allen et al., 2013). However, they become scarce in the GOA in fall, and most whales probably leave Cook Inlet and the GOA by October (Consiglieri et al., 1982). They primarily consume krill, and small schooling fishes (ADF&G, 2020c).

Migrating gray whale individuals and groups pass through Cook Inlet during their spring and fall migrations (Carretta et al., 2019; NOAA, 2020). They are mainly bottom feeders, getting their food by scooping up sediment and straining their food from the sediments using their baleen (ADF&G, 2020c).

Dall's porpoises occur year-round in Cook Inlet. They prefer deep water and use underwater canyons and deep channels to approach coastal areas when possible. They are present during all months of the year although some seasonal nearshore-offshore movements and winter movements of populations from coastal areas into and out of the GOA and Bering Sea likely occur (ADF&G, 2020c). Harbor porpoises are also common year-round in Cook Inlet where sea ice does not impede them. They often enter bays, harbors, estuaries, and large rivers, usually at depths of less than 91 m (300 ft) but will occasionally travel to deeper offshore waters in the winter. Both species feed on squid and a wide variety of small schooling fishes. Pacific white-sided dolphins are toothed whales that occur in the Proposed Lease Sale Area. They primarily feed on small schooling fishes.

4.8.1.2 Seals and Sea Lions

The Cook Inlet/Shelikof Stock of harbor seals is distributed throughout Cook Inlet during summer and from lower Cook Inlet through Shelikof Strait to Unimak Pass during winter (Boveng et al., 2012). Large numbers concentrate at the river mouths and bays of lower Cook Inlet, including the Fox River mouth in Kachemak Bay, and several resting areas (haul outs) have been identified on the southern end of Kalgin Island with over 200 haulouts in lower Cook Inlet (Rugh et al., 2005; Boveng et al., 2012; Montgomery et al., 2007). Large aggregations of harbor seals have been observed hauled out at the mouths of the Theodore and Lewis rivers during seismic monitoring programs (NMFS, 2015). They are most aggregated in Kachemak Bay, Iniskin and Iliamna bays, Kamishak Bay, Cape Douglas, and Shelikof Strait (Boveng et al., 2012). Harbor seals have higher population densities, more haulouts, and more breeding and pupping areas (rookeries) along the western coastline of Cook Inlet than along the eastern coastline (Boveng et al., 2012). Recent surveys show harbor seals favor coastal areas in spring and summer, and shift to areas outside of Cook Inlet in fall and winter with wide-ranging movements between winter use areas, particularly Shelikof Strait, Northern Kodiak Island, and coastal areas of the Alaska Peninsula (Boveng et al., 2012). In April and May, the seals return to Cook Inlet where they give birth and nurse their young (Boveng et al., 2012; London et al., 2012; Pitcher and Calkins, 1979). Harbor seals feed on fish such as salmon, squid, octopi, and crustaceans (Pitcher and Calkins, 1979; Jemison, 2001).

Steller sea lion habitat includes rookeries, haul outs, and marine foraging areas. Nearly all rookeries are at sites inaccessible to terrestrial predators on remote rocks, islands, and reefs. A few rookeries and haul outs occur in the southernmost coastal areas of Cook Inlet, and there are many haul outs and rookeries along the coast of Shelikof Strait, Kodiak, and the Kenai Peninsula. Sea lions are frequently seen in lower Cook Inlet and individuals, particularly juveniles, from the Eastern DPS (EDPS) and Western DPS (WDPS) frequently cross the 144˚W longitudinal boundary line separating the EDPS from the WDPS (Raum-Suryan et al., 2002). Steller sea lions feed on a variety of fish and invertebrate prey, indicative of a broad spectrum of foraging behaviors likely based on prey availability (NMFS, 2008b). Fecal analyses found pollock, Pacific cod, herring, and salmon are major prey species in the GOA and Cook Inlet (Merrick et al., 1997; Sinclair and Zeppelin, 2002).

The critical habitat designation for the WDPS of Steller sea lions includes a 37-km (20-nmi) buffer around all major haul outs and rookeries and other areas (50 CFR 226.202, August 27, 1993, as amended in 1999). One such Critical Habitat area lies close to the southeastern corner of the Proposed Lease Sale Area.

4.8.1.3 Northern Sea Otters

Two distinct stocks of northern 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 eastern Cook Inlet; the Southwest Stock's range extends from the west side of Cook Inlet, along the Alaska Peninsula to Bristol Bay, and includes the Aleutian, Barren, Kodiak, and Pribilof island groups (USFWS, 2014).

Sea otters generally inhabit nearshore waters <35 m (115 ft) deep and rarely range beyond the 55-m (180-ft) depth contour (Kenyon, 1969; Garshelis, 1987). They 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, and nearby waters. During summer, sea otters have been observed using areas within 40 m of shore where their best foraging opportunities occur (Bodkin et al., 2003; Riedman and Estes, 1990). Deep, wide channels with strong currents can act as partial barriers to their movements that greatly reduce their travelling. They are commonly found in lower Cook Inlet, particularly in coastal areas where they can access food and cover. Diving depth of sea otters is highly variable and ranges from 2–75 m (5–250 ft) and, depending on the prey species, may forage in shallow rocky and soft-sediment communities typically close to shorelines (ADF&G, 2020c; Estes, 1980; VanBlaricom and Estes, 1988; Bodkin et al., 2004). Sea urchins, crabs, clams, mussels, octopuses, other marine invertebrates, and fish make up their diet.

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 overlapping critical habitat (Figure 2-3). The geographic extent of sea otter critical habitat within the Proposed Lease Sale Area equates to a small percentage of northern sea otter critical habitat.

4.8.2 Environmental Consequences of the Proposed Action

4.8.2.1 Noise

Anticipated noise impacts from post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, include those from seismic and geohazard surveys, pile-driving, installation of platforms and pipelines, drilling, and traffic (vessel and aerial). Elevated noise levels in or near critical habitat areas are more likely to adversely impact the ESA-listed species those area designations are intended to protect.

Marine mammals use sound, sight, smell, and somatic (orientation of the body) senses to interact with their environment. Activities that produce sound can affect marine mammals by disrupting behavior, masking sounds, creating physiological stress and/or injuries such as hearing loss (temporarily or permanently). In addition to behavioral and physiological impacts, loud noises in some frequency bands can mask other environmental noises which could temporarily compromise an individual animal's ability to communicate, navigate, find food, and avoid hazard or predators. Overall, it is expected that whales, seals, sea lions, and sea otters would likely avoid activities that disturb them; however, the distance at which they react can vary greatly by species and site-specific conditions (e.g., activity type, duration, timing). Noise-producing activities occurring in the Proposed Lease Sale Area could adversely affect the hearing abilities and behaviors of marine mammals.

Most noises produced by post-lease activities as described in the E&D Scenario are incapable of injuring marine mammals or their prey because they lack the necessary source levels, and/or the noises do not occur in the frequencies that are likely to injure marine mammals (Richardson et al., 1995; OSPAR Commission, 2009; NMFS, 2018). Marine mammal responses would primarily amount to behavioral reactions that chiefly include avoidance, heightened alertness, and occasional temporary changes in diving activity. For all but the loudest noises, injuries to marine mammals could only occur if a marine mammal remains in an ensonified (filled with sound) area for an extended amount of time and even then, the injuries would most likely be temporary. In avoiding ensonified areas, some marine mammals may leave or abandon areas that would otherwise be considered important habitat. This could lead to very small energetic costs to individual marine mammals that should not have meaningful effects on their health.

Two activities have the potential to produce noise at frequencies and noise levels sufficient to cause acoustic injury to marine mammals: seismic surveys and pile-driving. Seismic surveys use airguns to produce impulsive, loud, low-frequency noise up to 237 decibels root mean square (dB_{RMS}) at the source in brief pulses every 6–10 seconds, primarily in narrow frequency bands around 200 hertz (Hz). It is assumed species with the best low-frequency hearing, such as baleen whales, would be more sensitive to airgun noise than species who hear best at higher sound frequencies above 300 Hz, such as harbor porpoises (Table 4-17). Other species with amphibious hearing capabilities (having both aerial and underwater hearing capability), such as pinnipeds and sea otters, do not echolocate and are not as sensitive to low-frequency noise as whales and porpoises. This is thought to explain their greater tolerance to airgun noise (NMFS, 2017).

Whales can begin responding to seismic surveys at distances of about 9.5 km (6 mi); however, they often do not respond until within a few kilometers (Richardson et al., 1995). Other groups of marine mammals such as sea lions, seals, and sea otters occasionally respond to airgun noise, but at other times show little or no reaction (Richardson et al., 1995, 1999, 2013; Madsen et al., 2002). Most likely this difference in response is due to their noise sensitivities and the activity individual animals were engaged in when exposure to airgun noise began. Because the onset of behavioral disturbance from noise depends on both external factors (source noise characteristics, background noise) and the receiving animal's status (hearing, motivation, experience, demography, level of habituation, current activity, and reproductive state), predicting exact behavioral impacts among individuals may be difficult (NMFS, 2017).

The loudest noises produced by seismic airgun arrays could temporarily or permanently compromise the hearing abilities of some nearby marine mammals. The term attenuation refers to the reduction of the amplitude of a sound signal with distance and dispersal of energy from the noise source. Because of attenuation characteristics of airgun noises in marine waters, the zone of potentially hazardous noise radiating out from an airgun array extends for several tens of meters, up to around 1,000 m (0.6 mi) from a survey depending on airgun array size (Richardson et al., 1995). The zone for potential injury for arrays used in Cook Inlet has been much smaller than 1,000 m with typical radii above 190 dB_{RMS} radiating out for no more than a few hundred meters from airgun arrays (NMFS, 2017). The likelihood of injury depends on sound intensity, frequencies where the noise occurs, distance of the animal from the sound source, type of noise (impulsive vs. continuous), and duration of exposure. Mitigation measures that include, but aren't limited to, the use of PSOs and operational modifications such as shutting off airguns in the presence of marine mammals that are too close to the survey, would prevent or reduce injuries to marine mammals from occurring (Baker et al., 2013; NMFS, 2017).

Belugas can react to seismic operations at distances greater than 20 km (12.4 mi) depending on the airgun array, and data suggests they could be more sensitive to airgun noise than their known hearing abilities would indicate (Table 4-6; Gordon et al., 2004; Ellison et al., 2012; Richardson, 1995; Sysueva et al., 2018; Mooney et al., 2018; Miller et al., 2005). Under certain conditions, behavioral responses may occur at even greater distances (Potter et al., 2007; DeRuiter et al., 2006; Goold and Coates, 2006; Tyack et al., 2006). Belugas, if present in the vicinity of survey activities, would likely avoid the area unless they are engaged in feeding or social activity (Erbe and Farmer, 2000). Due to the affinity most beluga whales have to the upper reaches of Cook Inlet during most of the year, they should be unaffected by seismic operations in the Proposed Lease Sale Area during summer, and sea ice presence would likely prevent seismic surveys from being conducted in winter where it could affect them (https://cispri.org/sea-ice/). For these reasons, seismic surveys have a low likelihood of impacting beluga whales. However, in 2019 monitoring detected at least one beluga whale near Port Graham in lower Cook Inlet concurrent with a seismic survey in the Proposed Lease Sale Area. This information suggests a few individual belugas could be in the lower inlet when seismic surveys occur, and could be impacted (Castellote et al., 2020).

Humpback, minke, fin, and gray whales generally avoid operating airguns, but their avoidance reactions also vary with species, location, whale activities, oceanographic conditions, and noise characteristics (Gordon et al., 2004; Richardson et al., 1995; Cato et al., 2013; Dunlop and Noad, 2017; Dunlop et al., 2018, 2020; Noad et al., 2011). Whales have also been reported to show no overt reactions to pulses from large seismic surveys at distances beyond a few kilometers, even though the noise pulses remain above ambient sound levels out to greater distances. Likewise, baleen whales have demonstrated tolerance to vessels and sonar operations. However, when exposed to strong airgun noises, they often deviate from migration routes or cease feeding and move away (Gordon et al., 2004; Johnson et al., 2007; Malme et al., 1984; Malme and Miles, 1985; McCauley et al., 1998; 2000a, b; Nowacek et al., 2007; Richardson, 1995; Weir, 2008). NMFS (2017) determined seismic surveys in Cook Inlet can create a 9.5-km (6-mi) radius zone with enough noise to elicit behavioral changes and injuries among marine mammals at close range.

Seismic airgun operations, particularly the larger 2D/3D surveys, have the greatest potential for noise impacts to sea otters, harbor seals, and sea lions (NMFS, 2017; USFWS, 2013, 2017). Steller sea lions mainly occur in the lower inlet and based on existing marine mammal surveys and proximity to their critical habitat areas, would likely be encountered by seismic surveys, but less often than harbor seals due to population differences and distributions between the species. Monitoring suggests seals and sea lions typically do not react strongly to airgun operations, often watching from within 300 meters (984 ft) of a survey until it passes them by (NMFS, 2016, 2017; Beland et al., 2013).

Impacts from airgun operations would consist of exposure to non-injurious intensities of low frequency noise that would result in temporary behavioral responses from marine mammals. This is due to the short-term avoidance marine mammals show; required mitigations such as posting PSOs onboard vessels and shutdowns of operating airgun arrays if marine mammals are detected in close proximity (Section 3.3.2); small behavioral responses; and lack of injuries among marine mammals associated with seismic surveys in Alaska. Overall, most marine mammals would avoid approaching seismic surveys before they could be seen or physically affected. However, there is a low likelihood some marine mammals could remain near seismic surveys and be adversely impacted (NMFS, 2017; Castellote et al., 2020).

Pile-driving, both impact and vibratory, which would occur during platform installation, can produce noise intense enough to injure marine mammals at close range (Richardson, 1995; CH2M, 2016; Castellote et al., 2019). Though the source levels from pile/pipe/sheet driving are usually above the injury thresholds established by NMFS (2018), noise levels drop considerably within a short distance from the source (Blackwell, 2005; Greene and Moore, 1995). Typically, the louder underwater noise levels from such activities do not radiate beyond one kilometer (0.6 mi) from the source, and as with airgun operations, the most common response from marine mammals is to avoid the noisiest areas until the activity ceases (Moulton et al., 2003; Malme et al., 1988; Richardson 1995; Castellote et al., 2016; DOSITS, 2020; Horwitz et al., 2015; Nehls et al., 2016; Denes et al., 2016). With prolonged and repeated exposure (within a few hundred meters of the source), pile-driving is capable of producing auditory injury to whales and seals (Blackwell, 2005; Greene and Moore, 1995; SLR, 2017). In general, marine mammals avoid areas where pile-driving occurs. Overall impacts to marine mammals from construction and industrial equipment noise, other than that of pile-driving, should be short-term, highly localized, and non-injurious.

Exposure to noise from the construction of platforms and pipelines may result in tolerance, avoidance, or displacement of marine mammals around operations (NMFS, 2015). Because construction and equipment noise would be ongoing and continuous, whales, seals, and sea otters would be alerted to increasing noise levels and should not intentionally enter into an area where they would suffer from acoustic injury or experience enough noise disturbance to challenge their viability (NMFS, 2015, 2017; USFWS, 2017). Impacts from construction and equipment noise have been found to be restricted to the immediate vicinity of MODUs or platforms by a margin generally less than 10 m (33 ft) (BOEM, 2015a; Austin et al, 2015; LGL/JASCO/Greeneridge, 2014). In nearshore regions, Greene and Moore (1995) found noise from pipeline trenching was not detectable beyond 20–25 km (12–16 mi) from the source.

Richardson et al. (1995) summarized the results of numerous studies and decades of research that showed that OCS drilling produces continuous noise that leads to avoidance by many marine mammals with no meaningful lingering effects. This assumption is further supported by more recent studies and syntheses of noise and marine mammal response data (Rossi-Santos, 2015; Bach et al., 2010; OSPAR Commission, 2009). The most probable type of drilling platforms that would be used in the Proposed Lease Sale Area (Section 4.1) are jack-up rigs or other forms of MODUs that can remain stable in Cook Inlet. They are less noisy than several other commonly used drilling platforms, and in Cook Inlet jack-up rigs produce underwater noise that is close to or below ambient noise levels, making for a relatively small acoustic footprint (Richardson et al. 1995).

Depending on the noise levels and whale activity at the time, all marine mammals may exhibit various reactions to drilling operations. Belugas have been shown to have greater displacement in response to a moving sound source, and less displacement or behavioral change in response to a stationary sound source (NMFS, 2015). When drilling sounds were played to belugas in industry-free areas, the whales showed a behavioral reaction only when received levels were high (Richardson and Würsig, 1997). They have been regularly observed approaching to within 100–150 m (328–492 ft) of operating MODUs without perceived effect (Richardson, 1995). The most likely effect drilling noise would have on other cetaceans, pinnipeds, or sea otters would be similar, such that individual animals avoid the area immediately adjacent to drilling operations before resuming their normal distribution and activity patterns once drilling ends.

Vessels produce the loudest regularly occurring man-made noises in Cook Inlet (NMFS, 2017). For this analysis most vessel traffic is assumed to occur along the Kenai coastline (NMFS, 2017). Vessels used in industrial activities produce sound below the intensity required to cause injury to marine mammals. The most likely response to vessel noise from marine mammals would be brief avoidance of the area around the vessel with temporary changes in vocalizations, as the vessel noise temporarily masks other environmental noises (Lesage et al., 1999).

Marine mammal responses to rotary and fixed-wing aircraft vary depending on flight altitude and received sound levels. Pinnipeds on haulouts often exhibit overt escape responses to helicopters and low-flying fixed-wing aircraft; however, aircraft noise quickly attenuates upon reaching the sea surface and has no known direct or indirect effect on marine mammals underwater (Born et al., 1999; Richardson, 1995; Burns and Harbo, 1972; Faye, 1982). Seals could partially habituate to aircraft flights up to some point; beyond which, they could become more sensitive and responsive to an increase in air traffic

(Richardson, 1995). Short-term behavioral responses to helicopters from members of the weasel family (which includes sea otters) have been documented in several locations, including Alaska, and it is assumed the responses of sea otters would be similar to what was described for other species in those studies (Patenaude et al., 2002; Richardson et al., 1985a, b). The minimum 457-m (1,500-ft) aircraft altitude requirement USFWS and NMFS typically require for OCS activities in Cook Inlet would also ensure aircraft noise minimizes impacts on cetaceans, pinnipeds, or sea otters (Section 3.3).

4.8.2.2 Habitat Alteration

Oil and gas activities can result in temporary or permanent alteration of habitat for marine mammals. Post-lease offshore activities conducted as a result of LS 258, as described in the E&D Scenario, which could physically alter marine mammal foraging habitat are platform installation, and other infrastructure or equipment placement on or below the seafloor. Activities that could alter marine mammal habitats include pipeline routes and installation, travel routes for aircraft and vessels, and discharges or releases of materials from vessels and platforms.

Oil and gas activities can result in temporary or permanent loss of habitat reducing the amount or types of prey available to marine mammals if prey species are injured, killed, or excluded from an area, or if prey quality or quantities are lessened (NMFS, 2015). A reduction in the amount or types of prey available to marine mammals may reduce their fitness or lead to mortality (Burek-Huntington et al., 2015). However, the area affected at any given time would be limited and likely have no measurable adverse effects to prey populations or the marine mammals that feed on them.

The installation of offshore production platforms in other cold seas has had a positive impact on fish-eating marine mammals, because the production platform infrastructure provides vertical structure benefitting some fish and invertebrate species (Russell et al. 2014; Thomson and Johnson, 1996; Todd et al., 2009). Consequently, adverse impacts of seafloor disturbance and habitat alteration from the presence of production platforms could be offset by the creation of more productive feeding habitat and better feeding opportunities for porpoises, harbor seals, Steller sea lions, and sea otters.

The placement of pipelines in and on the seabed would change the character of the seafloor along pipeline routes for several years until the site returns to its original ecologic state (McKellar, 2014; ADF&G, 2020c; EPA, 2017; Ridgway et al., 2011). Burying pipelines would displace benthic habitat along the pipeline trench for several years. Benthic-feeding marine mammals such as sea otters, pinnipeds, and gray whales would not use the impacted habitat as efficiently until the disturbed seabed recovered. These activities would not affect food availability over the long-term because prey species have broad distributions, and marine mammals forage over large areas of Cook Inlet and the GOA. Pipeline installation could adversely impact marine mammals and their habitat if they make landfall at a location that affects biologically important coastal areas (haulouts, river mouths, and estuaries).

Discharges or releases of drilling muds, cuttings, tailings, and other materials into lower Cook Inlet should not affect any marine mammals because currents and tides would widely disperse the solids in very small concentrations, eventually flushing the materials out of Cook Inlet and into the GOA.

4.8.2.3 Disturbance

The primary responses of marine mammals to disturbances include avoidance, habituation, and often visitations to identify the disturbance. Non-acoustic disturbances caused by vessels, vessel strikes, seismic survey equipment, MODUs and production platforms, people at work, and aircraft, could occur as a result of post-lease activities conducted as a result of LS 258, as described in the E&D Scenario. Vessels could disturb and temporarily displace whales, pinnipeds, and sea otters from transit routes. However, vessel traffic should not disrupt migrations or elicit responses greater than deflections around vessels. During spring migrations whales are unlikely to encounter any vessels associated with the proposed activities since most seismic surveys and exploration drilling in Cook Inlet occur in summer and fall. Additionally, fall migrating species would head south away from the Proposed Lease Sale Area and most likely not encounter vessels associated with the activities described in the E&D Scenario. Furthermore, all critical habitat for Steller sea lions and most critical habitat for Northern sea otters and beluga whales occurs outside of the Proposed Lease Sale Area, so there is little potential to affect critical habitat areas.

Baleen whales often tolerate the approach of slow-moving vessels within a few thousand feet, especially when the vessel is not headed towards them and when there are no sudden changes in direction or engine speed (Heide-Jorgensen et al., 2003; Richardson et al., 1995; Wartzok et al., 1989). Vessel strikes on marine mammals are considered a possibility, particularly for fin and humpback whales. Since both fin and humpback whales rank at the top of the global list for vessel strikes, and noticeably react to erratically moving vessels, it is assumed they would be at greater risk for vessel strikes (NMFS, 2017). Dead whales occasionally wash ashore in Cook Inlet with indications of vessel strikes, however, no data suggests those injuries were associated with oil and gas activities in the Inlet.

Beluga whales have been shown to respond to vessels by altering call types, frequency use, and call rates, and avoiding ships (Finley et al., 1990; Lesage et al., 1999). The response of belugas to vessels is thought to be partly a function of habituation (NMFS, 2017). Physical impacts such as ship strikes are not anticipated because belugas detect and avoid vessels and are able to outmaneuver slow-moving vessels as needed. This ability of belugas to avoid being struck by vessels is indicated by a lack of documented vessel strikes on beluga whales, and a shortage of observations involving belugas with injuries from vessel encounters.

Porpoises and toothed whales frequently investigate vessels, often "playing" in the wake of moving vessels, while pinnipeds and sea otters often show limited responses to vessels, with increased alertness, diving, moving from the vessel's path by up to several hundred meters (or feet), or by ignoring the vessel (USFWS, 2017; NMFS, 2017). A number of variables determine whether a marine mammal is likely to be disturbed by vessels. These include wind direction, the number of vessels, distance between a vessel and the animal, vessel speed and direction, vessel type and size, and the contextual habituation, threat association, and activity of the marine mammal (e.g., feeding, resting, sleeping).

Harbor seals and Steller sea lions frequently habituate to the presence of vessels, especially in places where vessel traffic is heavy. However, large, slow-moving vessels that would be used in the potential post-lease activities were determined to present little threat to seals and sea lions (NMFS, 2017; USFWS, 2017; Bonner, 1982; Jansen et al., 2006).

The USFWS determined disturbances from vessel traffic were likely, particularly if drill sites were placed in sea otter critical habitat, and that those disturbances would be greatest during summer when sea otter pups are in open waters, away from their nearshore wintering areas (USFWS, 2017). Because the likely shore bases are located on the eastern side of Cook Inlet, routine vessel traffic is not expected to transit through sea otter critical habitat. For this reason, sea otters occurring in the western portion of sea otter critical habitat would mostly remain unaffected by vessel traffic from post-lease activities (USFWS, 2017).

In their Biological Opinion for Lease Sale 244, which was similar to the proposed action, NMFS determined vessel strikes from post-lease activities have a remote likelihood of injuring marine mammals (NMFS, 2017). The application of existing USFWS and NMFS requirements for reduced vessel speeds to <10 knots in the presence of marine mammals, not approaching within 100 m (328 ft) of any marine mammal, not making multiple changes in direction within 274 m (900 ft) of marine mammals, and using PSOs to monitor and aid in avoiding marine mammals, should mitigate impacts from vessel traffic (Section 3.3; NMFS, 2017).

4.8.2.4 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on marine mammals are described in Section A-3.6 of Appendix A. Small spills could not affect marine mammal populations but may temporarily affect a few individual marine mammals behaviorally or physiologically. Spill drills are short-term (generally one day) and introduce noise and physical disturbance into a localized area and for these reasons are generally considered to be unlikely to adversely affect marine mammals. A large offshore oil spill could temporarily or permanently affect marine mammal physiology and behavior and could alter their habitats until the oil is removed or disperses. These impacts could affect individuals but would not affect marine mammal populations due to the reasonably foreseeable volume of a large spill. The effects could include avoidance of oiled areas, compromised thermoregulation for sea otters, skin/eye lesions, and ingestion or inhalation of oil and VOCs damaging the organs and compromising organ function, with a few potential marine mammal fatalities. Spill responses would produce highly localized areas of noise and physical disturbance, with brief, temporary behavioral effects to marine mammals from noise. Because of its limited size and the fact that a large gas release would quickly disperse, it would produce temporary behavioral and physiological responses among nearby individual marine mammals but would be unlikely to impact marine mammal populations.

4.8.2.5 Conclusion

The impacts of noise on marine mammals from post-lease activities resulting from LS 258, as described in the E&D Scenario, would lead to individual animals avoiding the most heavily ensonified areas, particularly around seismic surveys and pile-driving. Both types of activities could acoustically injure members of some species; however, avoidance should prevent injuries from occurring. Furthermore, the sound levels needed for injuries to occur typically require a marine mammal to remain within the loudest noise zones for an extended period of time, which would be unlikely. Thus, the effects of noise on marine mammals are expected to be short-term and produce temporary behavioral responses. Implementation of the typical requirements of NMFS and USFWS (Section 3.3) established through ESA consultation or operator-obtained MMPA authorizations would minimize impacts. These include the use of PSOs, vessel avoidance, and ramp-up/shut-down operations procedures. These measures would make the potential for injuries less likely.

Long-term disturbances to marine mammal habitat would occur with the installation of production platforms and pipelines. Disturbances such as pipeline installation and dredging would disturb linear swaths of habitat; however, those areas would eventually return to normal function, while discharges from drilling and other activities would not affect marine mammal habitats. The installation of platforms would also disturb benthic feeding areas for some marine mammals. However, over time those platforms would become colonized by invertebrates, potentially becoming artificial reefs, which provide habitat for small schooling fishes. Such changes can be advantageous for smaller fish-eating marine mammals.

Aircraft flying above 457 m (1,500 ft) would not be expected to have injurious or localized impacts on marine mammals; however, vessel traffic could lead to injuries if a vessel was to accidentally strike an individual. The typical requirements of NMFS and USFWS (Section 3.3) for vessels include PSOs monitoring for marine mammals, and marine mammal avoidance practices, which would make such events extremely rare and unlikely.

Collectively, impacts from post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, accidental small spills, and spill drills on marine mammals, would mostly consist of non-injurious, short-term effects resulting in temporary behavioral reactions by affected individuals, and would not result in population-level effects. Seismic airgun use and pile-driving could injure or kill a few individual marine mammals; however, the assumed mitigation measures (Section 3.3) would prevent injuries or deaths from occurring so the overall effects would be behavioral responses in some marine mammals. Small amounts of benthic habitat could be altered for long periods of time from the installation of platforms and pipelines, which could be slightly detrimental to benthic-feeding marine mammals. For platforms, such impacts are partially mitigated by the accompanying positive impacts of increased food availability for fish-eating marine mammals. Likewise, vessel strikes could injure or kill marine mammals, but with the USFWS and NMFS mitigations, vessel strikes would not occur, and the impacts of vessel traffic would prevent marine mammal injuries from occurring, though behavioral responses by marine mammals would continue. For these reasons, the overall impact of post-lease activities associated with the E&D Scenario, accidental small spills, and spill drills on marine mammals would be negligible to minor, with minor impacts for most species. With the addition of a large spill, the impacts would be minor to moderate, with minor impacts for most marine mammal populations other than sea otters. Sea otters could experience a moderate level of impacts from a large spill due to the severe adverse effects oiling often has on the insulative integrity of their fur.

4.8.3 Environmental Consequences of the Alternatives

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

The overall impacts for marine mammals under these alternatives would remain unchanged from those described for the Proposed Action, although some reduction in impacts may occur for certain species or areas. Alternative 3A excludes 10 OCS blocks that overlap with beluga whale critical habitat within the Proposed Lease Sale Area and reduces impacts on beluga whales in the excluded area. Alternative 3B would reduce the risk of noise impacts on beluga whales by prohibiting seismic activity in critical habitat during times when beluga whales are likely to be present. Alternative 3B would be less effective than Alternative 3A in reducing overall impacts because impacts unrelated to noise could still occur in beluga whale critical habitat. Alternative 3C, which limits seismic activities throughout the entire Proposed Lease Sale Area during seasonal beluga movements and near feeding areas, would reduce the risk of noise impacts to beluga whales, Steller sea lions, harbor seals, and sea otters. Because of the longer scheduling restrictions and the larger area protected, the mitigations outlined in Alternative 3C would protect more marine mammals compared to the Proposed Action or other alternatives, and lower the likelihood of disturbing marine mammals, especially during summer when they feed near river mouths. These alternatives would not protect marine mammals from potential adverse impacts from OCS activities occurring on other OCS lease blocks. Because marine mammal populations would not be protected from impacts outside of the mitigated areas or months, the overall impacts of Alternatives 3A, 3B, and 3C would be the same as those for post-lease activities described in the E&D Scenario, including accidental small spills, spill drills, and large spills – negligible to moderate. However, these alternatives would provide an additional measure of protection to beluga whales by limiting activities in or near beluga whale critical habitat in Cook Inlet.

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

The overall impacts for marine mammals under these alternatives would remain unchanged from those described for the Proposed Action, although some reduction in impacts may occur. Alternative 4A would reduce the risk of impacts on sea otters by excluding seven OCS blocks that overlap SW DPS sea otter critical habitat from leasing. This exclusion would eliminate seafloor disturbing activities and reduce vessel traffic that could adversely affect northern sea otter habitat. Alternative 4B would also reduce impacts on sea otter foraging areas by prohibiting discharges and seafloor disturbance near sea otter critical habitat but would not reduce vessel traffic. Alternative 4A provides the most protection for sea otters by protecting their critical habitat, compared to the Proposed Action or Alternative 4B. However, impacts that occur outside of the excluded or mitigated areas would not be affected by these alternatives. For marine mammal populations, the overall impacts of Alternatives 4A and 4B would be the same as those for post-lease activities described in the E&D Scenario, including accidental small spills, spill drills, and large spills – negligible to moderate. However, these alternatives would protect the physical integrity of critical habitat in Cook Inlet for use by northern sea otters.

4.8.3.3 Alternative 5 – Gillnet Fishery Mitigation

Potential impacts on marine mammals under Alternative 5 would not differ substantially from those described for the Proposed Action. Under this alternative, impacts on marine mammals from active acoustic sound sources would be reduced due to the mid-June through mid-August restriction of seismic operations during important summer feeding and rearing times; however, seismic surveys could occur in this mitigation area at other times of the year, so marine mammals would still experience noise impacts. For marine mammal populations, the overall impacts of Alternative 5 would be the same as those described in the Proposed Action, including accidental small spills, spill drills, and large spills – negligible to moderate.

4.8.4 Cumulative Effects

Sources of cumulative effects on marine mammals include oil and gas operations, maritime vessel traffic, oil spills, dredging, commercial and sport fishing, and subsistence hunting (Section 3.2). Climate change is considered another source of cumulative effects on marine mammals because it changes baseline environmental conditions. Oil- and gas-related activities have been occurring in Cook Inlet waters managed by the State of Alaska since the 1960s (Section 3.2, Table 3-5 and Table 3-6). The effects of past Cook Inlet oil and gas exploration and development on marine mammals have been short-term with no population-level impacts, and responses of marine mammals to oil and gas activities have consisted of inconsequential behavioral reactions by individual marine mammals (NMFS, 2017). Most effects expected from post-lease activities resulting from LS 258, as described in the E&D Scenario, would be temporary, occur on a small spatial scale, and unlikely to substantially overlap in time and space with the actions described in the Past, Present and Reasonably Foreseeable Future Activities section (Section 3.2). However, where the actions do overlap, impacts from noise, habitat alteration, and disturbance would occur, and should be similar to the effects described for the Proposed Action (Section 4.8.2). Large or chronic oil spills could have a cumulative effect on some marine mammals in Cook Inlet through deaths, reduced fitness or, if large quantities of oil contact areas where marine mammals aggregate, population-level impacts. In Cook Inlet, climate change impacts are expected to have the greatest long-term impacts on marine mammal populations – by far greater than any other event, activity, or combination of activities.

Impacts from cumulative effects of post-lease oil- and gas-related activities that could result from LS 258 and other Cook Inlet oil and gas exploration and development activities include increased exposure to loud noises, disturbances, and habitat alteration occurring from seismic surveys, pile-driving, drilling, installation of platforms and pipelines, and vessel and aircraft operations. These activities may impact marine mammals by introducing manmade noise into the environment, disturbing marine mammals with the presence of people and transportation, altering marine mammal habitat, and potentially injuring or killing individual marine mammals. All activities involving workers in marine environments have potential to temporarily disturb marine mammals; however, the only activities that could alter habitat are those that physically change parts of the marine environment or introduce chronic disturbances from noise or the presence of workers. Activities such as vessel traffic and commercial fishing, as well as accidental oil spills, have occasionally resulted in marine mammal fatalities. Similarly, small numbers of sea otters, harbor seals and Steller sea lions are harvested by subsistence hunters in Cook Inlet and Cook Inlet beluga whales were subject to subsistence hunting until the practice was stopped (Mahoney and Shelden, 2000).

Activities producing excessive amounts of noise include seismic surveying, pile-driving and other construction activities, drilling for oil or gas, vessel or air traffic, and dredging. The loudest of these activities are seismic surveying, pile-driving and other construction activities, and dredging; all of which have potential to compromise a marine mammal's ability to hear and properly interact with their natural environment. Typically, the noise levels from these activities are loud enough to permanently injure marine mammal hearing, but usually only at close range and over extended periods of time. Most noises produce behavioral responses from marine mammals, but seismic surveys and pile-driving produce noises that could be loud enough to injure nearby marine mammals (Section 4.8.2). For injuries to occur among marine mammals, exposures would have to occur in close proximity to noise sources or be exposed to loud noises continuously over extended periods of time (Section 4.8.2), both of which are highly unlikely.

Since marine mammals usually avoid areas of loud noises, temporary periods of exposure to noise from activities described in the E&D Scenario should not be additive or synergistic with cumulative effects from other sources on marine mammals or the physical habitat available to them. Drilling, vessel, and air traffic noise could interfere with the ability of a marine mammal to hear and discriminate between local environmental background noises but are not loud enough to produce injuries. Although Alternatives 3 and 4 would not reduce the overall level of potential impacts of post-lease oil and gas activities as considered in the E&D Scenario, they could reduce noise exposures on beluga whales, sea otters, and other marine mammals from airguns, pile-driving and construction, and drilling. In addition to producing noise, such activities can have impacts that include habitat alteration, environmental contamination from oil and gas spills and discharges, decreased prey availability, and physiological stress.

Some Cook Inlet marine mammal habitat has already been altered, primarily by the construction and use of ports in coastal areas, production platforms, pipelines on the seafloor, community growth, and commercial fishing. To a lesser extent the release of drill cuttings and muds, the establishment of consistently used vessel routes, oil and gas spills, and release of contaminants into Cook Inlet have also modified marine mammal habitats. Though some habitat has been altered and alterations are expected to continue into the future due to these developments, practices, and accidents, collectively they constitute a small fraction of marine mammal habitats in Cook Inlet. Within a matter of years or perhaps a decade or more, disturbed habitats often return to a state similar to that of unaffected areas (Henry et al., 2017; Mair et al., 1987; Manoukian et al., 2010). The installation of platforms in Cook Inlet may have had a positive impact on feeding opportunities for some marine mammals and could continue to do so into the future (Section 4.8.2). The construction and operation of oil and gas facilities and infrastructure; ports and pipelines; and other infrastructure developments would also require workers to be present during the construction, maintenance, monitoring, and decommissioning phases of operations. The presence of workers, vessels, aircraft, and equipment would produce disturbances that could cause marine mammals to avoid areas where work occurs, which might displace them from their habitat. Likewise, marine mammals in areas disturbed by activities conducted by the Departments of Defense and Homeland Security and from research, commercial and recreational fishing, and vessel transportation may cause marine mammals to temporarily or permanently abandon habitats. Future disturbances of these types would continue in parts of Cook Inlet into the foreseeable future, as would the associated effects. This proposed action would add to the cumulative disturbances by contributing short-term localized noise. The overall effect of disturbance is small with only temporary, localized, and low-level incremental additions from the Proposed Action.

Activities having the greatest direct mortality on marine mammals include subsistence hunting, commercial fishing, and maritime transportation. Subsistence hunting has historically occurred for harbor seals, sea lions, beluga whales, sea otters, and other marine mammals. Presently it accounts for a harvest of about 104 Cook Inlet/Shelikof Strait harbor seals and a small number of Steller sea lions annually (Muto et al., 2020). The current trends in harvest numbers are likely to remain stable into the future. Marine mammal mortalities occasionally occur from commercial fishing as entanglements in fishing gear or as bycatch. Such mortalities are few and infrequent (Muto et al., 2020). A secondary effect of fishing, particularly commercial fishing, is the annual removal of large numbers of fish and invertebrates that marine mammal prey on, which decreases food availability to marine mammals.

Vessel strikes on marine mammals occur occasionally in Cook Inlet; however, most vessel traffic in Cook Inlet is from fishing, recreation, and commercial traffic, not oil and gas activities (Eley and Nuka Research & Planning Group, 2006; Nuka Research & Planning Group and Pearson Consulting, 2015; Nuka Research & Planning Group, 2012; Kerkvliet et al., 2012). Cook Inlet's fleet of commercial fishers included nearly 1,000 smaller vessels registered on the Kenai Peninsula (Eley, 2006). Small boats travel faster and change direction more frequently than larger vessels, and Vanderlaan and Taggart (2007) found most marine mammal strikes involve fast-moving vessels. Consequently, the likelihood of large, slow-moving vessels typically associated with oil and gas activities striking a marine mammal is very low and should remain low into the future. Since maritime transportation should increase in the future in response to growing communities, the number of vessel strikes to marine mammals will likely increase, though most likely not from vessels working for the oil and gas industry (Neilson et al., 2012). Selection of the alternatives excluding critical habitat in Cook Inlet for protected species would reduce the potential for post-lease activities resulting from LS 258 to contribute to cumulative effects. The selection of these alternatives would also prevent a need for oil- and gas-related vessel and air traffic operations in those protected areas.

Accidental oil and gas releases have occurred in Cook Inlet and are likely to occur in the future, mostly when transporting oil or gas during lease development in state waters, and from infrastructure projects such as port developments. Most such spills would be small, easily managed and remediated, and of no consequence to marine mammals. Appendix A also considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. Since oil and gas development began in Cook Inlet, large spills have occasionally occurred; some of which were larger than what is assumed in Section 3.1. These past spill impacts make analysis of impacts of post-lease activities resulting from LS 258 possible (Section 3.1; ADNR, 2020a). The lack of chronic or major effects from such spills suggests similar impacts would be expected from accidental spills now and in the future. Impacts from contacting oil spills could include elevated stress and physiological reactions to inhalation or ingestion of hydrocarbon toxins and fouling of baleen or fur (Section 4.8.2 and Appendix A). The existence of spill response infrastructure, protocols and an active spill response would ensure adverse effects from large oil spills would have small impacts on marine mammal populations other than sea otters. Some sea otters could be injured or killed after contacting an oil spill, mostly due to their physiology and habitat requirements that make them more vulnerable to oil spill impacts than other marine mammals. For these reasons, the overall cumulative effects of a large oil spill within the past, present, and RFFAs would most likely be temporary physiological effects among marine mammals, other than a few sea otters which could become injured or die.

The largest contributor to cumulative effects on marine mammals in Cook Inlet is climate change which includes increasing ocean temperatures and acidification. This contributor can have adverse impacts on marine mammals such as increased incidence of disease (Guimarães et al., 2007), exacerbation of the effects of illness or bioavailability of contaminants (Schiedek et al., 2007), increased ocean noise levels (Reeder and Chiu, 2010), changes to the density and distribution of prey species (Welch and Batten, 1999; Whitney and Freeland, 1999), and other habitat changes. The most profound climate change impacts are predicted to occur after 2046, after most E&D Scenario activities would have ceased (Markon et al. 2018; UAF, 2018).

Impacts of climate change on marine mammals would likely vary between species due to varying dependencies of each marine mammal species on a range of resources. For example, in recent years, a large warm water “blob” developed in the North Pacific which forced many shoaling fish deeper into the water column, most likely affecting foraging success for some marine mammals. Increasing ocean temperatures and/or acidification could increase the growth and toxicity of phytoplankton associated with harmful algae blooms (Tatters et al., 2012). Some species of harmful algae produce acidic neurotoxins capable of damaging brains and internal organs, causing seizures and sometimes death in marine mammals (Anderson et al., 2014; McHuron et al., 2013; Kirkley et al., 2014; Jensen et al., 2015). More acidic waters also adversely impact the development of molluscs and other invertebrates using calcium carbonate-based shells and exoskeletons, and marine arthropods (Gazeau et al., 2013; Taylor et al., 2015; Whiteley, 2011). A compromised ability to form exoskeletons or shells could reduce the quality or quantity of bivalve and arthropod prey species available to marine mammals, particularly for sea otters. Post-lease activities resulting from LS 258, as described in the E&D Scenario, along with other past, present, and RFFAs in Cook Inlet should not appreciably increase climate change impacts. For this reason, the potential contributive influence of activities associated with the E&D Scenario on the most serious climate change impacts to marine mammals in and around Cook Inlet, is limited.

In sum, past, present, and RFFAs have affected and will continue to affect, marine mammals. Effects from these activities include exposure of marine mammals to increased noise, habitat alteration, disturbance and pollution from oil and gas activities; increased risk of strikes, noise, and/or pollution from vessel and aircraft traffic; competition for prey with, and potential entanglement from, commercial, recreational, and subsistence fisheries; mortality from subsistence hunting (a moratorium was placed on hunting beluga whales in 2005, but subsistence hunting of other marine mammals, especially seals and sea otters, still occurs); and disturbance or mortality associated with scientific studies. Despite exposure to these activities, most marine mammal populations remain stable to increasing in Cook Inlet. This includes the listed population of fin whales, humpback whales, Steller sea lions, and sea otters, but does not include beluga whales, whose population continues to decline.

Overall, the incremental impacts of potential post-lease activities resulting from LS 258, as described in the E&D Scenario, is expected to be small, when added to the other past, present, and reasonably foreseeable future anthropogenic activities. The post-lease activities would overlap both spatially and temporally with current activities that potentially affect marine mammals. While the post-lease activities have the potential to affect individual marine mammals in Cook Inlet, impacts would be short-term, localized, and non-injurious. This includes the endangered beluga whale, which would be in upper Cook Inlet when the E&D Scenario activities would occur and would most likely remain unaffected by noise and disturbances. Thus, the contribution of effects from the E&D Scenario activities to the overall cumulative effects on Cook Inlet marine mammals is expected to be minor absent the impacts of climate change. When impacts of the E&D Scenario are combined with those of future climate change, those major climate change impacts on marine mammals will not be appreciably increased.

4.9 Terrestrial Mammals

4.9.1 Affected Environment

Approximately 43 species of terrestrial mammals are known to occur in the lower Cook Inlet area. None of these species are currently listed as threatened or endangered, and most populations at the species level are considered stable (IUCN, 2015). Among the terrestrial mammals in the region, brown bear, black bear, caribou, and moose are most likely to be affected by post-lease activities that could potentially result from LS 258, as described in the E&D Scenario.

4.9.1.1 Brown Bear

Coastal regions of Alaska support the highest densities of brown bears and also the largest specimens (Glenn, 1980). Utilization of summer and fall salmon runs by brown bears to rapidly gain weight in preparation for hibernation is well known. In addition, the coastal environment 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, 2004). Susitna Flats State Game Refuge and Redoubt Bay on the west side of Cook Inlet are important grazing areas for brown bears during the spring (ADNR, 2009). In addition, 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 (Glenn, 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 (Smith and Partridge, 2004).

These intertidal areas support large concentrations of bears until the arrival of salmon draw the bears to fish spawning rivers, particularly the Kustatan River on the west side of Cook Inlet, Susitna River at the north end of Cook Inlet, Anchor River on the Kenai Peninsula (ADNR, 2009), and 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 (ADF&G, 2020a). Salmon runs are important for maintaining brown bear populations in the Cook Inlet region. Ungulates, such as moose or caribou, are also included in the diet of the brown bear (ADNR, 2009; ADF&G, 2020a).

4.9.1.2 Black Bear

Alaska supports a population of approximately 100,000 black bears (ADF&G, 2020a). Black bears range throughout the Cook Inlet area from sea level to alpine areas (ADF&G, 1994). 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 (ADF&G, 2020a). 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 et al., 2005).

Like brown bears, black bears in the Cook Inlet area are heavily dependent upon coastal habitats from the time they emerge from their dens until they return in the fall. Upon emerging from hibernation, black bears mainly eat freshly sprouted green vegetation, but also prey on newborn moose calves (ADF&G, 2020a). 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, and slopes between Drift River and the South Fork Big River on the west side of Cook Inlet (ADNR, 2009). During the summer and fall, black bears concentrate feeding activity on spawning salmon in areas where they are available (ADF&G, 2020a). Where salmon are absent, black bears rely heavily on vegetation, supplementing their diet with berries and insects (ADF&G, 2020a).

4.9.1.3 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. The Kenai Lowlands Herd is the only herd that could potentially be impacted by post-lease activities resulting from LS 258.

The Kenai Lowlands Herd on the west coast of the central Kenai Peninsula numbers 120 animals (Herreman, 2015). 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 migrates up the Kenai River to the Moose River Flats (ADF&G, 2003).

4.9.1.4 Moose

Moose are found throughout the Cook Inlet area except for the Kodiak Archipelago (ADNR, 2009). They are particularly abundant in riparian areas, recently burned areas with willow and tree saplings, and on timberline plateaus (ADF&G, 2020a; ADNR, 2009).

Flooding and fire maintain dense stands of willows and other fast-growing plants that provide abundant browse for moose (Woodford, 2006). Seasonal movements of moose are related to food availability as well as life cycle requirements. In spring, moose forage on graminoids, forbs, shrubs, and tree saplings, adding aquatic plants to their diet during summer. On wintering areas, such as coastal or riparian areas, moose browse willow, birch, cottonwood, aspen, and occasionally young spruce tips (ADF&G, 2020a; ADNR, 2018). Calving occurs in early spring, typically in shrubby or forested areas that provide forage for mothers and cover for calves (Bowyer et. al., 1999). 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, 2018). The known moose calving area near Homer extends to within a few miles of the Anchor River (ADF&G, 1985). In spring, moose cows give birth to one or two calves which remain with their mothers for around one year.

4.9.2 Environmental Consequences of the Proposed Action

4.9.2.1 Noise

Terrestrial mammals may experience increased levels of disturbance from post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, primarily due to increased noise from air traffic. The E&D Scenario considers 14 flights per week between the platforms and Homer or Nikiski during exploratory drilling and 7–42 flights per week during the peak development, production, and decommissioning phases. This amount of traffic would not be a substantial increase over aircraft traffic already present in the Cook Inlet region.

Noise can affect animal physiology and behavior (Radle, 1998), and strong long-lasting noise can have long-term impacts on reproductive success and survival (Radle, 1998). For example, caribou have been shown to exhibit panic to aircraft flying at low elevations, and exhibit escape responses (trotting or running from aircraft) to aircraft flying at 150–300 m (500–1,000 ft) (Calef et al., 1976). Aircraft disturbance of grizzly bears can produce avoidance behaviors including alertness, flight, aggression, or temporary displacement from an area, depending on circumstances (MMS, 2007, 2008; BOEMRE, 2011). 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, development, and production activities have been in operation for decades, and animals utilizing habitats in proximity to these airports most likely are already desensitized to the noise produced by aircraft operations.

While support flights from the Kenai Heliport in Nikiski may represent a small 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. 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. As most flights would involve approaching or departing 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 noise of a helicopter without being disturbed. These sounds may briefly startle some individual animals, but animals that forage routinely in the area would be expected to have become conditioned to the brief bursts of sound (Radle, 1998). The duration of the impact would be brief, lasting a matter of minutes.

Aircraft in support of post-lease oil exploration, development, and production in Cook Inlet resulting from LS 258 would not be expected to impact terrestrial mammal populations. Terrestrial mammals inhabiting the areas adjacent to airports would be expected to be conditioned to the increased noise levels in these areas and therefore would be unlikely to be disturbed by the increases in aircraft traffic. For this reason, aircraft traffic potentially resulting from LS 258 and described in the E&D Scenario should have little to no effect on those species.

4.9.2.2 Habitat Alteration

Post-lease activities conducted as a result of LS 258, as identified in the E&D Scenario, which have potential to remove or alter terrestrial habitat include construction of onshore pipelines and facilities. Impacts would vary by wildlife species, the size and duration of the construction project, and the location of the constructed facility.

Habitat alteration would take place in terrestrial environments where pipelines from OCS platforms make landfall and where construction of a 128-km (80-mi) onshore oil pipeline corridor described in the E&D Scenario would occur. 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 and corridor would be small, considering the availability of adjacent habitats. Depending on the exact location of landfall, pipeline construction could impact habitat areas for caribou, moose, brown, and black bear.

Approximately 119 ha (295 ac) of coastal wetland habitats would be impacted by construction of offshore and onshore pipelines, and pipeline landfall activities. After habitat disturbance from installation of the pipeline, the affected area would return to an early ecological state that favors herbaceous vegetation and graminoids, and 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. Natural vegetation succession would happen within the next growing season for grasses and forbs, and 2–3 years for shrubs (Section 4.5). A small amount of habitat would remain unavailable for some terrestrial mammal species in the short-term, while other species such as moose and caribou would benefit from the fresh growth of willows and other browse species.

The planned timing of pipeline construction would prevent impacts on the moose wintering area because moose likely will have moved to summer feeding areas before the beginning of the construction season. If landfall is within the calving area, moose would be displaced from the immediate vicinity of construction. If pipeline landfall were to take place within the Homer calving area near the coast, resulting in a displacement of moose landward, habitat from which moose would be excluded would be relatively minimal due to the availability of calving areas further inland. Moose calving areas near Nikiski are several miles inland of the expected landfall location and corridor and would not be expected to be impacted by activity related to pipeline construction.

Overall, habitat alteration resulting from pipeline construction would be expected to have a short-term and localized effect on terrestrial mammal populations. Impacts primarily would be loss of access to, and use of, limited areas along the shoreline and the pipeline corridor resulting in displacement of affected individuals.

4.9.2.3 Disturbance

Disturbances from onshore support activities, described in the E&D Scenario, most likely to affect terrestrial mammals would consist primarily of increased 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 drilling wastes from shore bases to disposal facilities would not contribute a substantial increase to roadkill of terrestrial mammals due to an already high rate of roadkill. 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 (Herreman, 2015), and 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 (ADF&G, 2003). Transport along Highway 1 (the Sterling/Seward Highway) would involve passing through the winter range of the Kenai Lowlands Caribou Herd (Herreman, 2015). Traffic along the Sterling/Seward Highway between Homer and Nikiski would pass through known moose calving areas and winter concentration areas between Kasilof and Soldotna (ADF&G, 1985). Roadkill of moose is high on the western Kenai Peninsula (Selinger, 2010; Herreman, 2018) as well as in the vicinity of Anchorage (Battle and Stantorf, 2018).

Springtime foraging on beaches by brown and black bears could be impacted by construction related to pipeline landfall. Construction activities would also present an increased potential for interactions between bears and humans, including confrontations. However, Homer and Nikiski are areas where human populations are concentrated and the increase in bear-human interactions due to construction activity would be expected to be minimal.

Loading and unloading equipment, supplies, and drilling wastes would occur at established shore bases that terrestrial mammals are already habituated to and thus are not expected to have any impacts on terrestrial mammals in the area. While these post-lease activities related to LS 258 would represent an increase in vehicular traffic, it is not on a scale that would be expected to be substantially above normal traffic levels, so disturbance activities described in the E&D Scenario would likely have short-term and localized effects on terrestrial mammals.

4.9.2.4 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on terrestrial mammals are described in Section A-3.7 of Appendix A. Only small onshore spills have potential to contact terrestrial mammals or their habitat, and impacts would be limited. Spill drills would produce highly localized areas of noise and physical disturbance and have temporary behavioral effects to terrestrial mammals. A large spill and associated response could affect terrestrial mammals and their habitats until the oil is removed or disperses. Depending on spill characteristics, a large spill could result in impacts to terrestrial mammals ranging from non-injurious brief responses, to temporary behavioral responses, to some level of incidental mortality. Physiological effects could include skin irritation, ingestion and inhalation of oil and VOCs, lesions, organ damage, and in severe cases, death. A gas release could affect terrestrial mammals by temporarily causing them to leave an area.

4.9.2.5 Conclusion

Generally, post-lease activities that may result from LS 258, as described in the E&D Scenario are not expected to result in substantial effects on terrestrial mammals. Most impacts would be localized to the site of the project infrastructure offshore in the Proposed Lease Sale Area, geographically distant from terrestrial habitats. Onshore pipeline construction and disturbance would have short-term and localized effects. Therefore, activities that may occur as a result of LS 258 as considered in the E&D Scenario are expected to result in minor impacts to terrestrial mammals. In addition, while some individuals may be affected, severe impacts are not expected because population level impacts are not anticipated. Taken together with accidental small spills and spill drills, effects would remain minor. 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. Impacts on terrestrial mammals from a large spill, when combined with the minor impacts resulting from the activities described in the E&D Scenario, are also expected to remain minor due to the low potential for adverse impacts from oiling of individuals or habitats. While some terrestrial mammals could become oiled, there should not be any effects that could be measured at the population or subpopulation level.

4.9.3 Environmental Consequences of the Alternatives

Potential impacts on terrestrial mammals under all the action alternatives would not differ substantially from those described for the Proposed Action. These alternatives would not change the total level of post-lease activity expected to result from LS 258, as described in the E&D Scenario. The action alternatives address specific resources in Cook Inlet, including the beluga whale, northern sea otter, and gillnet fishery. Thus, none of the restrictions identified in these alternatives would be expected to change the likelihood or severity of impacts on terrestrial mammals. Overall, impacts of all these alternatives on terrestrial mammals would be essentially the same as those for the Proposed Action – minor for E&D Scenario activities, accidental small spills, and spill drills. Impacts to terrestrial mammals remain minor when a large spill is considered.

4.9.4 Cumulative Effects

Past, present, and RFFAs that could affect terrestrial mammals include oil and gas operations, large oil spills, and other non-oil and gas activities to include mining projects, scientific research, and military activities. Climate change is another source of cumulative effects on terrestrial mammals in lower Cook Inlet. The potential impacts to terrestrial mammals from these activities come from habitat alteration as a result of construction activities (facilities, roads, and pipelines); noise from aircraft, vehicles, heavy equipment, and construction; and disturbance from vehicles and heavy equipment.

The Past, Present, and Reasonably Foreseeable Future Activities section (Section 3.2) identifies additional oil and gas operations and mining projects to include construction of facilities, roads, and pipelines, and increased air traffic. Terrestrial mammals could potentially be impacted by these activities. In undeveloped areas, facility construction could either curtail access or remove important seasonal habitat. Persistent exclusion from foraging or calving areas would contribute to cumulative impacts and may be detrimental to survivorship and reproduction for some mammal populations. If construction were to occur in previously developed or in commonly available habitats, there would be little to no impacts. If construction were to occur in undeveloped areas, impacts would be greater, but still short-term and localized.

Terrestrial mammals could be exposed to large oil spills accidentally released from platforms or pipelines and would be most susceptible to adverse impacts from spills occurring in coastal areas or that affect foraging habitats or resources. Large oil spills could occur in Cook Inlet from related activities such as the domestic transportation of oil, import of foreign crude oil, and the development of oil on state lands and in state waters. Appendix A considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. Oil releases from these spills might expose terrestrial mammals via direct contact or through the inhalation or ingestion of oil or tar deposits or contaminated prey. Impacts from spilled oil could be synergistic with other impacts to prey items of terrestrial mammals. For example, if the salmon population is substantially impacted by an oil spill (Section 4.6), impacts on brown bears could increase beyond direct oil spill contact with synergistic impacts as brown bears are forced to abandon salmon food sources and search for alternate food supplies.

Other activities that could contribute to cumulative impacts to terrestrial mammals include continuing and increasing air traffic from military operations and scientific research. Impacts from aircraft traffic, human activity, and repeated disturbances in proximity to caribou, moose, and bears could have additional adverse effects on their populations. As human activity levels increase, so would the impacts on terrestrial mammal movements, foraging, and denning behaviors. Increased impacts associated with post-lease activities resulting from LS 258, as considered in the E&D Scenario, would likely be sporadic and spread out across the landscape. While some individuals could be permanently displaced from habitats, most likely the area of displacement would amount to tens to hundreds of meters. Given the amount of area available to terrestrial mammals, impacts would be short-term and localized and are unlikely to affect population abundance or distribution.

Changes in the physical environment resulting from climate change could impact coastal and estuarine habitats (Section 4.5) resulting in a change to the types of plants and habitats available for foraging. For example, spruce bark beetle infestations have impacted more than 900,000 acres in Southcentral Alaska (ADNR, 2020b), and are correlated with increasing temperatures. The volume of mortality caused by beetle infestation now exceeds the volume of growth (ADNR, 2001), and the large volume of dead trees can provide fuel for fires that would further alter habitat on the Kenai Peninsula. During the latter half of the twentieth century, an estimated 80 percent of wetland sites on the Kenai Peninsula experienced drying, and two-thirds of wetland sites decreased in size. This loss of wetlands was accompanied by a change from open, wet, and watered areas to wooded upland habitats (Klein et al., 2005). Moose may benefit in the short-term from an increase in post-fire browse, but over the long-term, loss of wetlands might reduce moose populations, and the decrease in suitable moose and caribou habitat would locally increase stress on those populations. Such an impact would be exacerbated by increased bear predation on young, particularly if it interferes with salmon runs that local bear populations rely on. The E&D Scenario lifespan overlaps with the expected effects of climate change on the landscape. The incremental contribution of E&D Scenario activities on habitat quality may compound effects of climate change through synergistic interactions. The level of effects will depend on the degree that climate change impacts terrestrial habitat of the Cook Inlet region. Depending on the scale of the vegetation changes and the response of individual populations, effects could be localized to widespread, and long-term.

The incremental contribution of post-lease activities that may result from LS 258, as described in the E&D Scenario, to the past, present, and RFFAs on terrestrial mammals is not expected to contribute measurably to the level of effects. Most impacts from activities considered in the E&D Scenario would occur in the OCS and offshore waters, remaining geographically separate from terrestrial mammals and their habitat, and would not produce long-term disturbances or population level effects. A large spill could have a minor level of effect on some terrestrial mammal populations and habitats in the contacted areas. Oil spill response activities would reduce the effects of a large spill to a negligible to minor level of effects. The overall impact from past, present, and RFFAs, when combined with post-lease activities that could occur as a result of LS 258, would be negligible and with the addition of large oil spills, effects would be minor. When considering climate change, the cumulative effects on terrestrial mammals could be varied ranging from minor to major.

4.10 Recreation, Tourism, and Sport Fishing

4.10.1 Affected Environment

Recreation, tourism, and sport fishing are important components of economic activity in Cook Inlet and the three 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. The saltwater sport fishery in Cook Inlet, freshwater sport fishery on the Kenai Peninsula, and clamming are an important part of the total economy. Sport fisheries also are an important part of recreation and tourism experiences of the area. For more information on the economy of the KPB, see Section 4.12.

Alaskans generally participate in two broad categories of outdoor recreation: user-based recreation and "wildland" or resource-based recreation (ADNR, 2016). User-based recreation plays an important role in serving daily recreational needs. This type of recreation is often family- or school-oriented. Examples of user-based recreational activities include outdoor court and field sports (e.g., tennis, basketball, softball, soccer), golf, hockey or ice skating, and playground activities. Examples of resource-based recreation include fishing, hiking, biking, horseback riding, hunting, camping, boating, surfing, nature study, and visiting historical sites. 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, 2016).

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-based industry in Alaska that has grown continuously since statehood (Colt, 2001).

Cook Inlet's many year-round recreational opportunities require 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" (MMS, 2003). Coastal-dependent activities require access to the coastline and water for the activity to take place. They include boating, sailing, kayaking, clamming, terrestrial and marine wildlife viewing, beachcombing, and fishing. 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.

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, national preserves, national wildlife refuges, and SOA resources (recreational areas, parks, and similar places). The SOA has a variety of resources related to tourism and recreation adjacent to the Proposed Lease Sale Area. Alaska's state parks are the primary roadside gateways to outdoor recreation (ADNR, 2016). State park units near the Proposed Lease Sale Area include the Captain Cook, Clam Gulch, Ninilchik, Deep Creek, Stariski, and Anchor River State Recreation Areas. Kachemak Bay State Park and Wilderness Park are also adjacent to the Proposed Lease Sale Area.

Marine sport fisheries 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 the ADF&G 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 (ADF&G, 2013; 2018). 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 Anchor River, Whiskey Gulch, Deep Creek, and the Ninilchik River; the Gulf of Alaska coast west of Gore Point; areas north of the Ninilchik River, Barren Islands, Seldovia, Homer Spit, Seward; and various points along the shoreline (Herrmann et al., 2001). Some of the most popular freshwater sport fishing occurs on the Kenai Peninsula to include Chinook and Sockeye Salmon runs in June and Coho salmon runs in late July through September.

Both freshwater and marine sport fishers include local fishers from the Kenai Peninsula, other Alaskans (from outside the Kenai Peninsula), and nonresidents. While recreational fishing is popular among residents, records indicate that charter sport fishing is not. In 2013, 79 percent of angler days recorded on saltwater bottomfish charters were attributed to nonresidents, and only 14 percent were attributed to residents (Sigurdsson and Powers, 2014). Halibut was the most harvested species comprising 53 percent of fish takes. Similarly, 86 percent of angler days in the saltwater charter salmon sport fishery were attributed to nonresidents, and only 9 percent were attributed to residents. A similar breakdown was reflected in freshwater charter hires and residency: 89 percent of freshwater angler days of effort were attributed to nonresidents in 2013.

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 2018 were 95 percent lower than in 2009 (ADF&G, 2013, 2018). Residents and nonresidents alike collect steamer clams, mussels, and various other shellfish in Kachemak Bay.

4.10.2 Environmental Consequences of the Proposed Action

4.10.2.1 Noise

Air traffic is the primary contributor of noise that could impact recreation and tourism resources, as it can change one's perception of a landscape, depending on the duration and frequency. The potential for the noise originating from planes and helicopters to affect recreation and tourism depends on the volume, locations, and timing 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. An example of such a disturbance would be near shoreline recreational use areas between Homer and Nikiski because the vessels and helicopters described in the E&D Scenario would be transiting between these localities and the platforms.

Overall, the potential for noise from aircraft related to post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, to noticeably affect recreation and tourism in adverse ways during the lifespan considered in the E&D Scenario would be expected to have little to no effect up to short-term and localized. The number of trips between the platforms and Homer or Nikiski are projected to be relatively low in the E&D Scenario — 14 flights per week during exploratory drilling and 7–42 flights per week during the peak development, production, and decommissioning phases. This amount of traffic would not be a substantial increase over aircraft traffic already present in the Cook Inlet region. The onshore support bases that would be used are established and 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.

BOEM anticipates that noise transmitted from fixed platforms would be weak due to the elevation of the structure (BOEM, 2012). 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 and would therefore have little to no impacts.

Little or no direct effects to the razor clam sport fishery would be expected from active acoustic sound sources or from drilling and equipment noise associated with the E&D Scenario. Acoustic noise from seismic exploration, for example, is not expected to extend to the shallow tidal nearshore areas where razor clams are harvested. It is also not expected that noise from drilling and equipment activities would carry into the intertidal areas of Cook Inlet where razor clam harvesting is most popular. Therefore, the fishery is unlikely to experience decreases in the numbers or availability of targeted clams. Effects to the overall clam fishery from noise associated with post-lease activities resulting from LS 258 are expected to have little to no impact.

4.10.2.2 Disturbance

Disturbance from vessels could cause space-use conflicts with waterborne recreational activities such as recreational marine sport fishing and waterborne wildlife viewing and sightseeing. Space-use conflicts would arise if vessels engaged in operations such as seismic surveys, drilling, or other support activities 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 post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, and recreational vessels would be limited. Most waterborne recreational and tourist activities in Cook Inlet occur nearshore, especially in or adjacent to national and state parks or other special-use areas such as wildlife refuges. In contrast, exploratory activities and most development and production operations would occur far enough from these areas to avoid space-use conflicts. Platforms would not be sited, and operations would not occur where they could obstruct navigable waters or areas of particular recreational value as referenced above. 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 after construction (the areas surrounding the three platforms described in the E&D Scenario would be an exception). Consequently, space-use conflicts between vessels that support post-lease operations resulting from LS 258 and recreational and touring vessels overall would have short-term and localized effects on recreation.

Onshore or nearshore support services could affect recreation and tourism activities if ongoing support activities at shore bases displace recreationists or tourist operations. For example, vessels 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 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 could be long-term but localized over the 40-year duration considered in the E&D Scenario.

The helicopters would use existing airports that could accommodate the additional flights needed to support post-lease activities that may result from LS 258, as described in the E&D Scenario. Operations would have a limited physical presence on land due to pipeline maintenance, and local support services would be based in areas of Nikiski and Homer that already support similar oil and gas activities. Operations considered in the E&D Scenario are expected to have overall short-term and localized effects on recreation and tourism.

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. Support vessel traffic is estimated to consist of one to two trips per platform per day from Homer or Nikiski. Deep penetrating 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, pursuant to USCG regulations, 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.

4.10.2.3 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on recreation, tourism, and sport fishing are described in Section A-3.8 of Appendix A. Small spills are not expected to persist on the water long enough to affect waterborne recreational activities and may only have minimal impacts to sport fishing activities. Spill drills and GIUEs would produce highly localized areas of noise and physical disturbance and have temporary effects to recreation and sport fishing. A large spill, depending on spill characteristics, could result in impacts to recreation, tourism, and sport fishing. Impacts from a large spill including response, would reduce the quality of the recreational experience and alter patterns of use of recreational and sport fishing areas. A gas release could temporarily affect recreation, tourism, and sport fishing.

4.10.2.4 Conclusion

The effects of post-lease activities that may result from LS 258 as described in the E&D Scenario, accidental small spills, and spill drills on recreation and tourism would primarily arise from disturbance in the form of space-use conflicts. In most instances, these activities take place in different locations or at different times. However, in the instances when they coincide, the duration would be short lived. Activities described in the E&D Scenario 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. Under these circumstances, it is likely that charters and individual sport fishers would be able to use alternative fishing grounds. Overall, the effects of post-lease activities that may result from LS 258, including small spills that do not persist on the water and are contained, on recreation, tourism, and sport fishing are expected to be minor. In addition, impacts are not expected to rise to severe levels due to the short-lived instances of space-use conflicts associated with E&D Scenario activities.

An accidental large oil spill and associated response could cause long-lasting and widespread effects to recreation, tourism, and sport fishing, especially where oil makes contact with the shoreline. An accidental large oil spill could contact the western side of the Kenai Peninsula, which would limit the ability of recreationists, fishing charter operators, and recreational clam gatherers to use specific locations. Overall, potential effects of a large spill on recreation, tourism, and sport fishing, when added to those effects expected from post-lease activities resulting from LS 258, are expected to be moderate.

4.10.3 Environmental Consequences of the Alternatives

Potential impacts on recreation, tourism, and sport fishing under all the action alternatives would not differ substantially from those described for the Proposed Action. These alternatives would not change the total level of post-lease activity expected to result from LS 258, as described in the E&D Scenario. These alternatives are directed at reducing impacts to certain important resources in Cook Inlet, and thus none of the restrictions identified in the alternatives would be expected to alter the likelihood or severity of effects on recreation, tourism, and sport fishing identified for the Proposed Action. Impacts of these alternatives would be essentially the same as those for the Proposed Action – minor for post-lease activities, accidental small spills and spill drills, and moderate with the addition of a large spill.

4.10.4 Cumulative Effects

Past, present, and RFFAs that could affect recreation, tourism, and sport fishing include oil and gas operations, large oil spills, and other non-oil and gas activities to include marine transportation, ports and terminals, and commercial fishing. The potential impacts to recreation, tourism, and sport fishing from these activities would primarily come from space-use. Climate change is another source of cumulative impact on recreation, tourism, and sport fishing in lower Cook Inlet.

Post-lease activities that could result from LS 258, as described in the E&D Scenario, would increase vessel traffic in Cook Inlet which currently also includes global cargo vessels docking at the Port of Anchorage, cruise ships, supply barges, and other such vessels including oil and gas, military, commercial fishing, survey, and research. With additional marine vessel traffic comes the potential for groundings, increased operational discharges, and fuel spills. In addition, the activities associated with the E&D Scenario could add to pipeline leaks of already existing marine and land-based oil and gas activities. However, each of these impacts would pose a short-term cumulative impact on the recreation, tourism, and sport fishing industries.

The types of impacts related to a large oil spill and associated spill response on recreation, tourism, and sport fishing are discussed in Section A-3.8 of Appendix A. Appendix A also considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. If those spills are also considered, the most likely effect would be a lengthier and prolonged recuperation period for recreation and tourism sites in the area affected, including sport fishing areas. A spill would result in space-use conflicts for sport fishers where limited access is afforded to sport fishing. These large spills may cause long-term and widespread impacts to the recreation, tourism, and sport fishing industry through loss of access to some areas due to contamination or cleanup activities.

The projected growth in industrial activities and vessel calls at ports, harbors, and terminals could contribute to an increase in space-use conflicts between vessels that support commercial operations and recreational vessels. However, most water-based recreational and tourist activities in the Cook Inlet region occur in nearshore areas, especially in or adjacent to national and state parks or other areas of special concern. In contrast, on-lease exploratory activities and most commercial operations for the E&D Scenario would occur far enough from these areas to avoid space-use conflicts. Consequently, the overall additive effects of post-lease activities that may result from LS 258 to existing impacts to recreation and tourism could range from little to no to short-term and localized when combined with increased vessel calls at ports, harbors, and terminals.

New weather conditions differing from the historical pattern caused by climate change would most likely pose a challenge for tourism, boating, and sport fishing, which rely on highly predictable water and air temperatures and calm seas. Changes in wind patterns and wave heights in Cook Inlet have been observed and are projected to continue to change in the future (Chapin et al., 2014). This may create challenges in planning leisure and tourism activities and may change preferred locations for recreation and tourism as weather patterns change and air and sea surface temperatures rise. In addition, infrastructure in the Cook Inlet region such as marinas, marine supply stores, boardwalks, hotels, and restaurants that support leisure activities and tourism could be negatively affected by sea level rise. They may also be affected by increased storm intensity, changing wave heights, and elevated storm surge due to sea level rise and other expected effects of a changing climate.

Overall, the cumulative impact to recreation, tourism, and sport fishing resulting from past, present, and RFFAs would be minor. The incremental contribution of post-lease activities that may result from LS 258 to cumulative effects on recreation, tourism, and sport fishing is not expected to contribute measurably.

4.11 Communities and Subsistence

4.11.1 Affected Environment

Communities on the Kenai Peninsula include small cities and towns that are connected by the road system, and several smaller, non-road-connected villages. Larger communities include the cities of Kenai (population 7,000), Soldotna (4,327), Nikiski (4,563), and Homer (5,443) (ADCCED, 2020). Coastal towns along the road system in the KPB range in size from just over 200 people in Clam Gulch to over 2,000 in Anchor Point (ADCCED, 2020). Community identity of many small cities and towns in the region is supported by the tourism, oil and gas, government, and fishing sectors (Sections 4.10, 4.12 and 4.13; KPEDD, 2015). The ethnic composition of the cities and towns in the KPB is predominately white, with smaller representation of Alaska Native and other ethnicities (ADCCED, 2020).

The sociocultural systems of the small, non-road-connected communities in the Cook Inlet region are supported by a limited economic base, with commercial fishing and seafood processing as primary income-producing occupations. These communities include the villages of Tyonek (population 168), Nanwalek (291), Port Graham (179), and Seldovia (181) (ADCCED, 2020). Alaska Native Peoples make up most of the population in these communities, although Seldovia is more diverse than the other villages. Other areas off the road system include Halibut Cove (population 83) on the south shore of Kachemak Bay, and Beluga (population 19) on the west side of Cook Inlet (ADCCED, 2020). Additionally, several Russian Old Believer communities on the Kenai Peninsula including Nikolaevsk and Voznesenka, maintain a traditional lifestyle supported by hunting and fishing.

Residents of communities throughout the region rely on subsistence resources for food and to support a rural lifestyle. Many residents participate in the harvest, use, and sharing of wild resources. Subsistence and personal use regulations under state laws apply to all Alaskans, and residents of some communities also qualify for subsistence priority under the Federal Subsistence Management Program. Additionally, subsistence activities are considered central to the cultural identity, social well-being, and health of Alaska Native communities. The importance of subsistence is reflected in high levels of participation; high harvest levels which produce a large portion of the local food supply; extensive sharing of subsistence harvests through kinship and other networks; and large investments of time and money in subsistence equipment, supplies, and activities. Subsistence hunting, fishing, and trapping occur year-round throughout the entire region on land, in rivers, and in coastal waters. Subsistence resources include salmon and other fish, big game, small game and furbearers, marine mammals, birds and eggs, marine invertebrates, and plants and berries.

The ADF&G, Division of Subsistence compiles data from a range of research efforts and conducts studies to gather information on aspects of subsistence uses in Alaska, including in the Cook Inlet region. The Division of Subsistence makes the information available through the Community Subsistence Information System (CSIS). Community-level information is available for some Cook Inlet region communities, with frequency and currency of data collection varying throughout the region. Characteristics of community subsistence harvests, based on data provided in the CSIS, are presented in the FEIS for Lease Sale 244, as part of its description of the affected environment for subsistence (BOEM, 2016a, Section 3.3.3). Specifically, information set forth in Table 3.3.3-2, identifies annual per-capita harvest amounts in pounds; per-capita percentage of resources harvested; and the percent of households that harvested, received, or gave away subsistence foods for studied communities. Table 3.3.3-3 shows the types of foods harvested and the percentage each type represents of consumable resources for each study community; and Figures 3.3.3-1 and 3.3.3-3 depict composite resource harvest areas for Tyonek, Nanwalek, and Port Graham. The information in these tables and figures, as summarized here and with more specificity below, is incorporated by reference in support of BOEM's subsistence analysis for LS 258. The information incorporated by reference remains current and thus informative for understanding subsistence uses in the region. To the extent new or additional data exists, BOEM has included it in its LS 258 analysis. Additional studies new to the LS 258 analysis include updated resource harvest amounts and locations for Tyonek (Jones et al., 2015) and for Nikiski, Seldovia, Nanwalek, and Port Graham (Jones and Kostick, 2016), and are included below in the discussion of subsistence harvests for communities on the western and eastern sides of Cook Inlet.

The data in Table 3.3.3-2 in BOEM (2016a) indicate large amounts of subsistence foods are harvested in each of the geographic areas surrounding Cook Inlet. Annual per-capita harvest in the Cook Inlet communities for which data was available, including the more recent ADF&G data (Jones et al., 2015; Jones and Kostick, 2016), ranged from 111 pounds in Hope (study year 1990) to 466 pounds in Port Graham (study year 2003) and was mostly in the 200- to 300-pound range. Annual per-capita harvest in the Cook Inlet Alaska Native communities of Tyonek, Nanwalek, and Port Graham was higher than in other Cook Inlet communities.

Salmon is an important resource for all communities, accounting for well over 30 percent of subsistence resources used in most communities and over 60 percent in many communities throughout the region, as shown in Table 3.3.3-3 in BOEM (2016a). Several personal use dipnet and setnet fisheries operate throughout the Kenai Peninsula, and a combination of commercial, subsistence, and rod-and-reel fisheries provide salmon for domestic use. Many subsistence users also fish commercially, taking a portion of their commercial harvest for subsistence uses (Jones and Kostick, 2016). Non-salmon fish and large land mammals make up the other main subsistence harvests. Marine invertebrates are another important subsistence food in some communities.

Subsistence activities are assigned high cultural values by local Cook Inlet Dena'ina, Alutiiq, and Koniag peoples; Alaska Native peoples in the region rely on subsistence resources for food and health, and to support cultural connections. 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 (Figure 3.3.3-1 in BOEM, 2016a). 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, along with waterfowl and clams (Jones et al., 2015). Some Tyonek residents harvest marine mammals (primarily harbor seals) in nearshore areas (Jones et al., 2015). Harvest activity in Tyonek occurs year-round with higher levels in the spring, summer, and fall (Jones et al., 2015; Stanek et al., 2007).

On the eastern side of Cook Inlet, residents of Seldovia, Port Graham, and Nanwalek harvest resources in onshore, nearshore, and offshore areas. Harvest areas for these communities are primarily on the southern tip of the Kenai Peninsula, especially at the mouth and along the southern shore of Kachemak Bay, as well as in Seldovia, Jakalof, Tutka, China Poot, Nanwalek, and Koyuktolik ("Dogfish") bays (Figure 3.3.3-3 in BOEM, 2016a; Jones and Kostick, 2016). Seldovia harvesters also fish for salmon and other fish farther offshore within the Proposed Lease Sale Area. Harvest areas for the communities of Seldovia, Port Graham, and Nanwalek overlap to an extent, with more concentrated usage in areas nearest each community. Area residents harvest seals, sea lions, and sea otters in nearshore areas around the southern part of Kachemak Bay and the southernmost point of the Kenai Peninsula (Wolfe et al., 2008). Primary waterfowl harvest areas are in the vicinity of Seldovia, Tutka, and China Poot bays and the McKeon and Fox River flats. Moose and black bears are hunted along local shorelines. Other resources, including non-salmon fish and shellfish, are used fresh in season. Farther north up the Kenai Peninsula, residents of Ninilchik harvest fish on the eastern side of Cook Inlet, primarily salmon, along with halibut and other fish, butter clams, and razor clams. Large land mammals are also an important resource for Ninilchik. Residents of the communities harvest wild resources throughout the year. Certain species are targeted in different seasons, with harvest patterns defined by seasonal resource availability, laws and regulations, other economic activities, and land access (Jones and Kostick, 2016).

Other areas farther from the Lease Sale area that have potential to be affected by a large oil spill include communities on Kodiak Island and the upper Alaska Peninsula that are adjacent to the Proposed Lease Sale Area. Fishing is an important industry and activity in these communities, along with harvest of other wild foods (Fall et al., 2012; Hutchinson-Scarbough et al., 2020; Marchioni et al., 2016).

4.11.2 Environmental Consequences of the Proposed Action

Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, would have impacts on communities in the Cook Inlet Region through effects on subsistence activities and harvest patterns. Impacts to subsistence relate to more than biological impacts and harvest amounts because they could affect communities' social organization, cultural identity, subsistence way of life, health, and well-being.

Potential impacts to subsistence activities and harvest patterns associated with activities considered in the E&D Scenario would primarily occur through changes in the availability of subsistence resources to harvesters and from space-use conflicts. Impacts on communities would also occur from changes in the economy and population of the region (Section 4.12) as well as commercial fishing (Section 4.13).

4.11.2.1 Resource Availability

Post-lease activities described in the E&D Scenario which could impact the availability of resources to subsistence harvesters include noise, seafloor disturbance, and operational discharges resulting in changes in the quantity, quality, or distribution of biological resources.

Noise, including active acoustic sound sources, drilling and equipment noise, and other operational noises, may impact subsistence harvest patterns by temporarily displacing or deflecting subsistence resources away from areas where harvesters can access them. As discussed in Section 4.6, underwater noise can produce localized and short-term impacts to fish that include dispersal of individuals from areas around sound-producing activities. Dispersal of fish away from waters near noisy activities could delay subsistence fishers in the immediate vicinity and result in potential short-term missed harvest. While subsistence fishing occurs throughout Cook Inlet, noise impacts in areas of high fishing activity, including near bays and river mouths, would have higher potential to impact subsistence fishing. In addition, because many commercial fishers remove a portion of their harvest for subsistence purposes, noise impacts on commercial fishing (Section 4.13) have implications for subsistence harvest amounts. However, subsistence users would likely be able to fish at other times and places during the season and impacts on subsistence fishing are expected to be short-term and localized.

Population-level noise impacts to marine mammals are not expected, but animals may be disturbed by or avoid noise-producing activities (Section 4.8). Activities that generate noise in nearshore areas have potential to overlap with marine mammal subsistence harvest areas (Jones and Kostick, 2016). These activities, such as nearshore pipeline construction or vessel traffic (discussed as part of space-use conflicts, below) could disturb marine mammals away from traditional harvest locations. However, most of the noise-producing activity considered in the E&D Scenario, including seismic activities and drilling, is not expected to overlap substantially with marine mammal subsistence harvest locations. Overall, noise impacts to subsistence harvest patterns and activities are expected to be short-term and localized within individual harvest seasons, but the potential for impacts would persist throughout the lifespan of oil and gas activities that may result from LS 258, as described in the E&D Scenario.

Seafloor disturbance could result from drilling, anchoring, platform and pipeline installation, seafloor sampling, and placement of other equipment on the seafloor. Subsistence species that might be impacted by seafloor disturbance include crabs, shellfish, certain fish species, and subsistence species dependent on them as part of the food chain. However, impacts to individual resources would be localized and would not result in changes to overall populations (Section 4.6). There would be minimal overlap of seafloor disturbances and harvest areas for marine invertebrates, which are mostly close to shore (Jones and Kostick, 2016). Localized disturbance in nearshore harvest areas could be associated with pipeline landfalls, depending on the landfall location. Temporary and localized impacts to subsistence harvest from seafloor disturbance may occur during pipeline construction.

Operational discharges, as described in Section 4.4, could occur over the life of the E&D Scenario. Cook Inlet subsistence harvesters have expressed concern about the effects of discharges on resources in Cook Inlet (Holen, 2019). Subsistence harvest patterns could be disrupted by harvesters' self-imposed restrictions on resources considered to be tainted. While discharges could occur at various times throughout the estimated lifespan of LS 258-related exploration and development, as considered in the E&D Scenario, NPDES permitting would regulate operational discharges to prevent, minimize, or mitigate the intentional discharge of effluents into Cook Inlet (Section 4.4).

Space-Use Conflicts

Post-lease activities that may result from LS 258 and considered in the E&D Scenario that could cause space-use conflicts include vessel, vehicle, and aircraft operations; and construction, operation, and maintenance of platforms and onshore pipelines. Space-use conflicts can result from activities that overlap in time and space with subsistence activities that would prevent or limit harvesters' access to subsistence use areas and resources.

Impacts to subsistence harvest patterns from vessel and air traffic during all exploration and development phases may result from the overlap of traffic activity with subsistence harvest activity. However, BOEM expects the overlap between vessel and aircraft traffic and subsistence activities to be minimal because the majority of oil- and gas-related aircraft and vessels would depart from existing on-shore bases in Homer or Nikiski and transit directly to offshore locations. This would reduce overlap with most nearshore subsistence activities by concentrating traffic in specific areas. In addition, minimum elevation requirements for aircraft and prescribed transit corridors for helicopters, intended to reduce impacts on marine mammals (Section 3.3.2), would reduce the likelihood of impacts on marine mammal subsistence activities from aircraft traffic. Short-term and localized conflicts could arise between subsistence fishing vessels and those supporting seismic and site clearance surveys, drilling, and construction activities (e.g., platform and pipeline installation), and harvesters would need to temporarily alter their harvest locations, timing, or levels of effort. Subsistence fishers may need to avoid localized fishing areas during seismic activities, and potentially other vessel operations, for safety. For example, longlines used by subsistence fishers could entangle with seismic survey equipment if fishing and survey vessels approach too closely. The USCG would issue a Local Notice to Mariners, which would specify the activity dates and locations and the recommended avoidance requirements for other vessel traffic. Potential conflicts with vessels would likely be localized to specific, pre-identified areas. Over the course of the LS 258 lifespan, as considered in the E&D Scenario, individual occurrences of space-use conflicts between vessels or aircraft and subsistence activities would be short-term and localized.

Construction and ongoing presence of offshore platforms and onshore pipelines has the potential to result in space-use conflicts with some subsistence users. Construction of platforms may lead offshore subsistence fishers to avoid localized harvest areas during construction activities, and continued presence of platforms may result in highly localized, but long-term, avoidance of harvesting in the nearby area surrounding platforms. Space-use conflicts resulting from construction of an onshore oil pipeline would depend on the pipeline location and route. If the oil pipeline was sited in or near traditional hunting and fishing grounds, space-use conflicts and disruptions to local subsistence harvest patterns could occur and result in short-term and localized impacts to subsistence users' patterns of harvest of terrestrial mammals, fish, birds, and vegetation. Because the E&D Scenario assumes an offshore gas pipeline would tie into existing onshore pipeline infrastructure shortly after making landfall, little to no impacts from an onshore gas pipeline are expected.

Impacts on subsistence activities and harvest patterns could be reduced through coordination between lessees/operators and Alaska Native communities to identify potential conflicts between planned oil and gas activities and subsistence or other cultural activities. Documentation of consultation with participating communities would help lessees/operators and communities identify best practices to prevent unreasonable conflicts with subsistence or other cultural activities, and outline specific mitigation measures the operator should implement. The degree to which such a measure would reduce impacts to subsistence would depend on implementation for specific exploration and development plans.

4.11.2.2 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on sociocultural systems, subsistence, and community health are described in Sections A-3.9, A-3.10, and A-3.11 of Appendix A. Most small spills would be localized and have limited geographic and temporal effects. Spill drills are not expected to impact subsistence because they would be infrequent, planned events that occur over short timeframes (usually one day). A large spill would have potential to disrupt subsistence activities, or to make subsistence resources unavailable or undesirable for use, or only available in greatly reduced numbers for a substantial portion of a subsistence season. Therefore, a large oil spill has the potential to cause severe impacts to subsistence activities and harvest patterns in Cook Inlet. A large spill also has a very small probability of occurring and contacting subsistence use areas for Kodiak Island and Alaska Peninsula communities (Section A-3.10.2.1, Appendix A). Although it is very unlikely to occur, it could result in severe impacts in affected communities in those regions. Impacts of spill response activities on communities would result from disruption of subsistence harvest and changes in employment of local residents and non-residents who work on spill response. Levels of impacts would depend on where cleanup activities occur in relation to communities and harvest areas and how long cleanup efforts last, and could range from short-term and localized, to long-term and widespread. A large gas release over one day would be expected to have short-term and localized impacts to communities and subsistence.

4.11.2.3 Conclusion

Short-term and/or localized impacts to subsistence activities and harvest patterns could occur throughout the 40-year lifespan associated with post-lease activities resulting from LS 258 under the E&D Scenario through effects on the availability of subsistence resources and space-use conflicts. BOEM does not expect that impacts from those activities considered in the E&D Scenario, small spills, and spill drills would 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. Overall, these impacts on communities and subsistence are expected to be minor. A large oil spill and associated spill response could substantially disrupt subsistence harvests and commercial fishing for one or more seasons, resulting in major impacts to subsistence activities and harvest patterns. Impacts of a large oil spill could extend beyond Cook Inlet communities to Kodiak Island and Alaska Peninsula communities.

4.11.3 Environmental Consequences of the Alternatives

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

Potential impacts to communities and subsistence under Alternatives 3A, 3B, and 3C would not differ substantially from those described for the Proposed Action. Excluding the 10 OCS lease blocks that overlap Critical Habitat for the beluga whale under Alternative 3A would avoid activities within those OCS blocks but is not expected to change the total level of activity resulting from LS 258 as considered in the E&D Scenario. Alternative 3B, Critical Habitat Mitigation, could change the timing of seismic survey and exploration activities within the 10 OCS lease blocks overlapping beluga Critical Habitat. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams (Alternative 3C) would decrease noise impacts 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 evaluated for the Proposed Action. For Alternatives 3A, 3B, and 3C, impacts to communities and subsistence would be minor for post-lease activities that may result from LS 258, accidental small spills and spill drills, and major with the addition of a large spill.

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

Potential impacts on communities and subsistence under Alternatives 4A and 4B would not differ substantially from those described for the Proposed Action. Neither excluding the OCS blocks under Alternative 4A nor the mitigation under Alternative 4B would be expected to change the likelihood or severity of impacts evaluated for the Proposed Action. Under Alternatives 4A and 4B, impacts to communities and subsistence would be minor for E&D Scenario activities, accidental small spills and spill drills, and major with the addition of a large spill.

4.11.3.3 Alternative 5 – Gillnet Fishery Mitigation

Potential impacts on communities and subsistence under Alternative 5 would be similar to those described for the Proposed Action, with a reduction in impacts in communities where commercial fishing is an important subsistence, economic, social, and cultural activity (Section 4.13). Alternative 5 would not be expected to change the likelihood or severity of overall impacts evaluated for the Proposed Action for subsistence activities and harvest patterns. Under Alternative 5, impacts to communities and subsistence would be minor for those activities described in the E&D Scenario, accidental small spills and spill drills, and major with the addition of a large spill.

4.11.4 Cumulative Effects

Communities in the Cook Inlet region are supported by subsistence and several other interconnected resources, including economy (Section 4.12), commercial fishing (Section 4.13), and recreation, tourism, and sport fishing (Section 4.10). Cumulative impacts on these resources are discussed in their respective sections and could translate to impacts in communities through changes in economic opportunities, population, health, and community character and identity. Subsistence activities and harvest patterns could be cumulatively impacted by oil and gas operations, large oil spills, mining projects, marine transportation and ports, national security activities, fishing, and residential and community development. Climate change is another source of cumulative impacts on subsistence in Cook Inlet. Potential cumulative impacts include changes in subsistence resource availability, changes in harvester access to subsistence resources or harvest areas, and harvester avoidance of resources or areas.

Types of impacts of past, present, and reasonably foreseeable oil and gas activities on subsistence would be similar to those described for those post-lease activities that may result from LS 258, but could occur on a larger scale. The activities attributed to leasing that result from LS 258, as described in the E&D Scenario, would combine with oil and gas activities onshore and in state and OCS waters to contribute to future impacts to fishing and hunting from noise, seafloor disturbance, discharges, traffic (vessels, vehicles, aircraft), and onshore activities and facilities. Impacts from post-lease activities that may result from LS 258, as described in the E&D Scenario, could be additive to those from other oil and gas activities if they occur in subsistence harvest areas within the same season(s). For example, cumulative noise impacts from oil and gas activities could extend the timeframe or area in which resource availability for subsistence fishers is affected, possibly limiting harvest amounts within a season. Additive space-use conflicts (such as from vessel and aircraft traffic) could result in short-term (less than one season) and potentially long-term (one or more season(s)) limitations on the use of harvest areas.

Appendix A considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. Potential future large oil spills would impact subsistence use areas. Subsistence use areas that are contacted by a large oil spill would likely be unsuitable for subsistence activities until adequately restored. Large oil spills that are not contained to platforms, pads, or areas in the immediate vicinity of infrastructure could contaminate important hunting and fishing areas and subsistence foods and would likely impact subsistence uses of those areas. Spill cleanup operations could result in the closure of harvesting areas until cleanup is complete, but persistent contamination could keep areas closed for years. Avoidance of affected areas or resources by subsistence users could further extend the timeframe of impacts. Historical spills have resulted in avoidance of spill-impacted harvest sites and resources that lasted beyond closure periods (Fall et al., 2006; Impact Assessment, Inc., 2011). Oil and gas activities overall, when large spills are considered, could have long-lasting, widespread, and possibly severe cumulative impacts to subsistence activities and harvest patterns.

Other activities described in Section 3.2 with potential to impact subsistence are marine transportation and port maintenance and expansion, mining projects, fishing, residential and community development, and military and homeland security. These activities may contribute to impacts from noise, seafloor disturbances, discharges, traffic, and onshore and nearshore construction activities. Past activities have cumulatively affected subsistence through changes in species availability and harvester access to subsistence use areas, increased competition for resources by other users, and changes in laws and regulations regarding resource uses (Jones and Kostick, 2016; Jones et al., 2015). For example, competition for resources and use areas with sport fishers has been reported in some communities and has changed uses of traditional harvest areas (Holen, 2019). Such trends are expected to continue. Many of the impacts on resource availability or harvester access to resources would be spatially separated from each other and from the impacts expected to result from LS 258 post-lease activities, as captured in the E&D Scenario, but they may result in space-use conflicts or effects on resource availability when overlap occurs. Overall impacts of non-oil and gas activities on subsistence would be mostly short-term and localized but could extend to long-term and widespread if activities occur in or near subsistence harvest areas.

Communities in the region are likely to be impacted by effects on resources related to climate change. Communities and industries reliant on marine-based fisheries would most likely be affected to the greatest extent, as would individuals and communities dependent on subsistence harvest of marine fish, invertebrates, and wildlife as essential elements of their food security and cultural well-being. Impacts on subsistence resource availability from climate change are expected over the lifespan of LS 258 exploration, development, and decommissioning considered by the E&D Scenario. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of subsistence species (Sections 4.6 through 4.9), thereby indirectly affecting subsistence harvest patterns. Warming oceans increases in ocean acidity, changes in land cover type, and other factors associated with climate change may cause or contribute to regime shifts in communities of subsistence species in Cook Inlet.

Range expansions may bring new subsistence species into Cook Inlet, while other species may become less prevalent. Subsistence harvest opportunities may be affected by potential shifts in hunting seasons and harvest opportunities due to changes in distribution or abundance of favored species (ADF&G, 2010). Cumulative impacts on subsistence activities and harvest patterns related to climate change could be short-term and localized or long-lasting and widespread and possibly severe depending on the extent to which availability of and access to subsistence resources are adversely affected.

The overall cumulative impacts on subsistence activities and harvest patterns from the activities described in Section 3.2 would be minor to moderate but could increase to major through impacts from cumulative oil spills and climate change. In the context of the potential long-term, widespread, and severe impacts on subsistence activities and harvest patterns related to climate change and cumulative oil spills, the impacts associated with the E&D Scenario would not represent a substantial incremental contribution to overall cumulative impacts.

4.12 Economy

4.12.1 Affected Environment

Employment income, royalty revenues, property taxes, and spending associated with the oil and gas industry are major contributors to the SOA and Southcentral Alaska's economy. The oil and gas industry generates average earnings greater than two-and-a-half times all other Alaskan industries (Fried, 2017).

The Swanson River oil field founded in 1957, located within the KPB, has been credited with helping provide economic justification for statehood. In 1969, the Kenai LNG facility began to produce LNG for export to Japan, Agrium began production of ammonia and urea used for fertilizer, and the Kenai refinery began operations. Both the Kenai LNG facility (2017) and the fertilizer plant (2007) have ceased operations, while the Kenai refinery is still operating. Cook Inlet Gas Storage Alaska (CINGSA) is a gas storage facility built on a depleted gas reservoir used to balance seasonal swings in demand and supply. CINGSA entered service in 2012. Oil and gas production in Cook Inlet basin are used in the local market with infrastructure available for oil, LNG, and fertilizer exports.

All developed oil and gas fields discovered in the Cook Inlet Basin to date are onshore or in SOA waters (BOEM, 2015a). Cook Inlet oil production started in the 1960s, peaked in 1970 at 227,000 barrels per day, hit a low of 8,900 barrels per day in 2011, and had increased to 14,300 barrels per day in 2019. Natural gas production began in 1960 in Cook Inlet and peaked in 1994, with a gross production of 310 Bcf produced per year with 100 Bcf reinjected, netting 210 Bcf of annual production. Current natural gas production, as of 2019, is 70 Bcf per year, with gross production of 79 Bcf with and 9 Bcf reinjected.

4.12.1.1 Employment and Wages

The oil industry has a large footprint in the SOA. Direct employment related to oil and gas accounted for 4 percent of the total Alaskan workforce (out-of-state workers excluded) and 11 percent of total wages in Alaska in 2015 (Fried, 2017); however, this does not include indirect jobs related to oil and gas pipelines, transportation companies, refineries, and many construction companies. Nonresidents represent 36 percent of the oil and gas workforce and earn 34 percent of its total wages (Fried, 2017).

The nearest communities that could be impacted by post-lease activities that may result from LS 258, as described in the E&D Scenario, include the KPB, the Municipality of Anchorage (a City and a Borough under state law), and the Matanuska-Susitna (Mat-Su) Borough. Identifiable economic effects are most likely to be associated with the KPB. Serving as a source of workers, KPB is likely to benefit from the related effects of income, spending, and taxes. Anchorage and the Mat-Su Borough could be sources of workers and recipients of spending. Oil and gas workers who commute from Anchorage and the Mat-Su are not considered permanent residents of the KPB; these workers would have minimal integration into the local economy.

Approximately 4,607 direct, indirect, and induced jobs in the KPB are attributed to the oil and gas industry, generating approximately $405 million in annual wages (Table 4-18; McDowell Group, 2020).

Category	Employment	Wages ($ million)
Primary Companies (Alaska residents only)*	852	206.4
Oil and Gas Support Services (Alaska residents only)*	1,382	99.8
All other Indirect and Induced	2,373	98.7
Total Impacts (Direct, Indirect, and Induced):	4,607	404.9

Notes: * Includes workers who are employed statewide but reside in the KPB, as well as workers who live and work in the KPB.
Source: Alaska Department of Labor and Workforce Development, data from Primary Companies, and McDowell Group estimates.

The KPB had 58,367 permanent residents in 2019 (ADLWD, 2019). Most KPB residents (90 percent) (ADLWD, 2016) do not rely on oil and gas jobs. Other employment opportunities include state and local government jobs, tourism, trade, utility, healthcare, retail, and hospitality industries. Infrastructure, work sites, and housing are integrated within KPB communities.

Unemployment in the KPB ranged from 14.9 percent to 6.8 percent between 1990 and 2020. The KPB unemployment rate in 2019 was 6.8 percent, slightly higher than Alaska's unemployment rate of 6.1 percent the same year (ADLWD, 2019).

4.12.1.2 Revenues

The federal government collects revenues from the production of oil and natural gas on the OCS through bonus bids, royalties, and rents from lessees. The U.S. Department of the Treasury distributes about half of the revenues generated from all oil and gas development in various proportions to the states and various national funds such as the Historic Preservation Fund, Land and Water Conservation Fund, and Native American Tribes and Allottees. The other half remains at the U.S. Treasury to fund other U.S. programs.

State revenue comes from petroleum, non-petroleum revenue from taxes, charges for services, licenses, permits, and fines and forfeitures. Federal oil and gas rents and royalties from OCS leases located 4.8–9.6 km (3–6 mi) from shore are shared under Section 8(g) of OCSLA. In FY 2019, SOA revenues totaled $7.7 billion, and petroleum revenue accounted for $2.0 billion of the total. Traditionally, petroleum revenues made up 85 percent or more of SOA revenues. For over two decades, approximately 80 percent of Alaska's unrestricted (funds for any purpose) revenue has come from oil taxation and royalties (ADOR, Fall 2018 RSB). Currently, the largest source of revenue for the SOA is the earnings reserve of the Permanent Fund (ADOR, Spring 2020 RSB).

A minimum royalty rate of 12.5 percent of gross value of oil and gas volumes produced is set by OCSLA for OCS leases, although the Secretary may impose a higher royalty rate or Net Profit-Sharing Lease provisions. The SOA also is entitled to a 27.5 percent share of certain OCS revenues from leases subject to Section 8(g) of the OCSLA; such leases would be within 3 nmi of the state's territorial sea boundary.

The majority of property tax revenue KPB receives comes from the oil and gas industry. Property tax is KPB's largest revenue source. In 2019, total property taxes collected were $69.5 million of which oil and gas property taxes were $14.1 million (KPB, 2019). The KPB has an effective mill rate of 9.90 mills. Other local jurisdictions have a mill rate of 0 to 20 mills within the SOA (ADOR, Fall 2019 RSB).

4.12.2 Environmental Consequences of the Proposed Action

4.12.2.1 Employment and Wages

Exploration, development, production, and decommissioning phases affect employment and wages to varying degrees. During the early stages of lease development, there are minimal impacts to the local economy due to the specific human labor skills required. Employment begins to increase during G&G data acquisition, analysis, and for numerous environmental studies needed for exploration. As development and production begin, the need for additional support services creates local employment opportunities. Employment continues to increase during exploration and development drilling. Employment reaches peak levels in the first several years when design, fabrication, installation, and initial production begin. Employment decreases as capital expenditure projects are completed, and spending transitions to an operational expenditures baseline. There is a slight increase in employment related to capital expenditures during decommissioning, while operational employment expenditures cease.

Out-of-state workers are estimated to compose 18 percent of the workforce. Because workers associated with E&D Scenario activities would be housed in the local community, there would be some impact to the local population. As development and production begin, the need for additional oil and gas support services could induce local employment opportunities in the KPB through the “multiplier effect.” The multiplier effect stems from operational expenses requiring additional services or local goods. These additional jobs may include, but are not limited to transportation, retail, recreation, education, healthcare, and potential oil spill response services. Due to this multiplier effect, indirect and induced jobs can exceed the number of jobs directly created by E&D Scenario activities. Employment, income, and expenditures resulting from E&D Scenario activities would initiate subsequent rounds of income creation, spending, and investments. An increase in jobs and wages during peak employment periods could generate an increase of spending in local communities, thus benefiting local businesses. This can be perceived by some as an increase in quality of life. Therefore, employment and wage effects could be long-term and may have widespread impacts for the KPB and SOA.

4.12.2.2 Revenues

The KPB and SOA both receive a share of revenues from assessed oil and gas exploration production facilities, and pipeline property taxes. Oil and gas property tax revenues support some KPB residents working in local government jobs. The KPB primarily receives its revenues from these oil and gas property taxes and not production revenue. A marginal amount of new infrastructure would be located on state lands, which is likely to consist of pipelines connecting to existing infrastructure. New infrastructure would have little to no impact on additional oil and gas property tax revenues received annually but would effectively increase the lifespan of some infrastructure on which the KPB collects property tax. Effects on property tax revenue based on extending the lifespan of existing infrastructure could be negligible to moderate, depending upon the amount of oil and natural gas discovered. For example, if enough natural gas is discovered, the LNG terminal and/or the fertilizer plant could be restarted which would provide a moderate boost to property taxes collected by the KPB. It is more likely any oil and gas discoveries would extend the lifespan of existing infrastructure, as utilization of existing assets would be optimized. Therefore, communities in the KPB could have limited or moderate impacts associated with oil and gas property tax revenues, as they would occur on a scale sufficient to create local changes in population, employment, wages, and KPB revenues.

Primary impacts to the SOA revenues include property tax, corporate income tax, and revenues received under Section 8(g) of OCSLA which shares 27.5 percent of royalty rents and royalty revenues received on leases located 4.8–9.6 km (3–6 mi) from State lands. These revenues would be the primary sources of revenue for the SOA from post-lease activities conducted as a result of LS 258, as described in the E&D Scenario. The SOA receives fewer beneficial impacts than the KPB. The activities associated with the E&D Scenario could result in negligible to minor revenue impacts for the SOA.

4.12.2.3 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on economy are described in Section A-3.12 of Appendix A. Levels of employment, wages, and revenues would remain unaltered in the case of small spills resulting in the accrual of little to no economic benefits in local communities. For a small spill, most of the cleanup would occur from those already employed in the oil and gas sector. Additionally, oil spill drills would have a short-term and localized impact and would be of no consequence to the economy. However, if a large oil spill were to occur, cleanup workers may provide a considerable amount of wages earned for those living in the affected community. A gas release would not have a substantial impact to the economy.

4.12.2.4 Conclusion

Impacts related to employment, wages, and revenues for the SOA from the activities associated with the E&D Scenario range from short-term and localized to long-term and widespread. Size and duration of impacts are tied to the size of a resource discovered — the larger the resource the greater the impact on employment, wages, and KPB revenues. If the resource discovered is large enough, the potential for reopening of the LNG terminal and/or fertilizer plant exists. Reopening of one or both facilities would provide a step function to the size of the impact on the KPB's revenues, employment, and wages. Impacts on KPB employment and wages are likely to range from temporary and short-term, to long-term and widespread. Oil and gas property revenues KPB receives are expected to remain constant, with the possibility of increased infrastructure longevity and associated property tax. A long-term and widespread impact to KPB property tax would be expected if one or both LNG/fertilizer facilities reopened, resulting in a moderate impact to the KPB.

Population impacts are expected to be negligible to minor over the lifespan of the E&D Scenario and subsequent developments. Overall, the economic impacts to the SOA would range from negligible to minor, while the KPB would experience negligible to moderate effects. When a large oil spill is analyzed, impacts to the SOA remain minor due to the localized impact of a large oil spill, the small change in statewide jobs, and the small percent of revenues lost as discussed in Appendix A (Section A-3.12). The KPB would experience minor impacts due to temporary increased employment and wages associated with a large oil spill cleanup, and the long-term effects to the mixed economy as discussed in Appendix A (Section A-3.12).

4.12.3 Environmental Consequences of the Alternatives

Potential impacts on the economy under all the action alternatives would not differ substantially from those described for the Proposed Action. These alternatives would not change the total level of activity under the E&D Scenario, and thus economic impacts would be as described for the Proposed Action. None of the restrictions identified by these alternatives would be expected to change the likelihood or severity of impacts on the economy. Consequently, economic impacts of these alternatives would be negligible for small spills and spill drills for the SOA and the KPB. When considering a large spill, economic impacts for the SOA and KPB would be minor. Economic impacts of these alternatives would be minor for E&D activities in relation to potential revenues for the SOA and the KPB.

4.12.4 Cumulative Effects

There are numerous past, ongoing, and reasonably foreseeable oil and gas projects in the KPB, adjacent state waters, and other areas of Cook Inlet. Current and reasonably foreseeable projects would continue to sustain existing statewide employment and labor income opportunities into the future. Positive effects to the economy may result from new and modifying infrastructure. Additional income opportunities include infrastructure construction/enhancement, support services for the oil and gas industry, community development, recreation, tourism, and local or tribal development. Employment and labor associated with improved infrastructure would maintain a longer-term tax base. The KPB government receives limited revenues from oil and gas property taxes and provides employment and income to KPB residents. Increased longevity of existing infrastructure would be significant to the KPB. Limited to significant property taxes would be recognized if the LNG terminal and/or fertilizer plants restarted in the manufacturing sector of the KPB. The amount of property tax would vary according to how much of the LNG terminal and/or fertilizer plant infrastructure is placed back in service. Consideration has also been given to a property tax break, which could occur before restarting this infrastructure. This creates a wide range of potential property tax revenues the KPB could receive. The SOA receives additional revenues from oil and gas beyond property taxes, unlike the KPB. Therefore, the State may comparatively experience larger economic impacts.

Employment patterns may be altered based on changes in seasonal drilling and exploration windows. Production patterns may be affected by these changes, as well. In addition to production from existing operations, ongoing exploration activities in Cook Inlet are occurring both onshore and offshore in both state and federal waters. Exploration activities include initial evaluation, geological survey, geophysical survey, and exploratory drilling. Limited development may occur, such as the Seaview natural gas project near Anchor Point. The activities associated with the E&D Scenario and these ongoing projects would contribute to the overall employment, revenues, and income for the KPB and SOA. The degree of incremental effect is dependent on industry interest/success, but it could be widespread and long-term.

The Past, Present, and Reasonably Foreseeable Future Activities section (Section 3.2) includes reasonably foreseeable potential income opportunities for the KPB and SOA. The primary contribution of the E&D Scenario to this part of the Cumulative Assumptions is additional employment and income, extending infrastructure lifespans and property tax revenues further into the future, and negligible to limited impacts to the local communities.

Activities associated with the E&D Scenario could prolong the life of existing onshore infrastructure and encourage future industry activity as oil fields are discovered and developed, thus resulting in additive economic benefits greater than the sum of the parts. Positive long-term impacts to the local economy would primarily come from sustained revenues. Small impacts would come from other employment opportunities.

A large oil spill or gas release, as described in the Oil Spills and Gas Release Scenario (Section 3.1), may have some effects on the economy. These impacts may overlap with reasonably foreseeable future activities, thereby increasing the overall level of the effect expected. Short-term impacts from a large oil spill would contribute to employment and wages and minimally impact the KPB and SOA revenues. When impacts from the E&D Scenario are added to past, present, and RFFAs, cumulative impacts to the economy would be minor to moderate.

4.13 Commercial Fishing

4.13.1 Affected Environment

The central Gulf of Alaska supports a large and diverse commercial fishery for shellfish, salmon, herring, and groundfish. Some species that are currently commercially harvested elsewhere in Alaska have been closed or greatly reduced in Cook Inlet over recent decades due to low stock levels (ADF&G, 2019a, b). It is possible that these fisheries could resume in Cook Inlet if population surveys showed harvestable abundances.

4.13.1.1 Crab and Shrimp

The ADF&G manages crab fisheries of the Cook Inlet, Kodiak, and Alaska Peninsula areas in cooperation with NMFS and the North Pacific Fishery Management Council. Seasons are established by ADF&G, and, for some species, harvest limits are set with coordination and in cooperation with the federal fisheries agencies. Due to low levels of abundance in the Cook Inlet area, fisheries for red king, Tanner and Dungeness crabs, and shrimp have been closed for some time (1983 for king crab, 1995 for Tanner crab, and 1997 for Dungeness crab) (Rumble et al., 2016, 2020). Cook Inlet commercial shrimp fisheries have included northern, sidestripe, coonstripe, spot, and humpy shrimp via pot or trawl gear. The shrimp fishery in Cook Inlet has been closed since 1997 due to low abundance (ADF&G, 2019b; Rumble et al., 2016). It is possible that a commercial harvest of these species could occur during the life of the project, if population estimates show appropriate numbers.

4.13.1.2 Scallops and Clams

Weathervane scallops are harvested by dredges while other hardshell clams are harvested by hand using shovels or rakes. Commercial weathervane scallop fishing in federal waters off Alaska is limited, but participation in state waters is open access. Scallops are harvested commercially during some years, but these efforts have been limited until recently. Catches have been sporadic and centered on a single scallop bed near Augustine Island in the Kamishak District of lower Cook Inlet from August 15 through October 31. The Cook Inlet scallop fishery is periodically closed based on management decisions (ADF&G, 2019b; Rumble et al., 2016). This pattern of variable open and closed years is likely to continue through the life of the Proposed Action. In the Cook Inlet area, Pacific littleneck and butter clams may be harvested by permit, but there are conservation concerns about their abundance. The last commercial harvest of these species in the Cook Inlet area occurred in 2006 in Kachemak Bay (Rumble et al., 2016). Commercial harvest of razor clams is managed by ADF&G. This fishery occurs throughout the year, historically occurring mostly in the western area of Cook Inlet.

4.13.1.3 Other Commercially Harvested Invertebrates

Other shellfish commercially fished in Alaska include octopus, sea cucumbers, and sea urchins (ADF&G, 2019b). Octopus are captured as bycatch of the Pacific cod pot fishery. Sea cucumbers and green sea urchins are harvested by divers, but that commercial fishery has been closed in Cook Inlet since 1997 (Rumble et al., 2016).

4.13.1.4 Pacific Herring

Pacific herring are harvested annually in Cook Inlet as well as the waters adjacent to Kodiak, Chignik, and the South Alaskan Peninsula. The ADF&G divides Cook Inlet into upper and lower management districts, each with a different management team. Herring are targeted mainly for their roe and sac roe on kelp, but some carcasses are processed into fishmeal after the sac roe is removed. This gill net fishery occurs during April and May. In lower Cook Inlet, a commercial herring fishery has been on and off for much of the twentieth century (Hollowell et al., 2016). The most recent one was located in Kamishak Bay, but due to low stock abundance, it was closed in 1999 and has remained closed in order to allow the population further opportunity to rebuild from historically low abundance (ADF&G, 2019a; Hollowell et al., 2016).

4.13.1.5 Salmon

All five species of Pacific salmon are harvested commercially in Cook Inlet and the waters adjacent to Kodiak, Chignik, and the southern Alaska Peninsula. ADF&G and the appointed Alaska Board of Fisheries manage the salmon stocks in the Cook Inlet, Kodiak, and Alaskan Peninsula areas (ADF&G, 2017). 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, ADF&G has the authority to impose emergency closures and other management actions to increase the number of salmon reaching the spawning grounds. Cook Inlet salmon fisheries use purse seines, drift gillnets, and set gillnets from June through August. Second only to Alaska's groundfish fishery, Alaska's salmon fishery is one of the largest fisheries in volume and value. The estimated total value of salmon fisheries in 2018 was approximately $7.2 million in lower Cook Inlet (Hollowell et al., 2019).

4.13.1.6 Groundfish

ADF&G and NMFS share and coordinate management responsibilities for Alaska's groundfish fisheries. Management of halibut is also coordinated with the International Pacific Halibut Commission. The groundfish fishery is the largest commercial fishery in Alaska by volume and value, but most Alaskan groundfish are landed in the Bering Sea/Aleutian Islands area outside the Proposed Lease Sale Area. Commercially harvested groundfish in Cook Inlet have included, but are not limited to, rockfish (several species), flatfish (including halibut), Pacific cod, lingcod, sablefish, and pollock. Groundfish are harvested with trawls, pots, longlines, and small sunken gillnets throughout the year. Halibut is a major commercial groundfish fishery in the Cook Inlet area for much of the year; landings in 2019 were recorded to be over 10 million lbs (IPHC, 2019). In 2018, an estimated 1.5 million lbs of groundfish (other than halibut) were harvested in Cook Inlet, with a value of approximately $924,000. This is as low as values in the 1990s; catches in recent decades were higher and were mostly due to catches of Pacific cod. Allowable groundfish harvest was reduced in 2018 due to a downturn in Pacific cod populations in the Gulf of Alaska. Sablefish, rockfish, and pollock harvest in Cook Inlet in 2018 was also low. Lingcod have seen an increase in harvest value in recent years (NPFMC, 2019; Rumble et al., 2019).

4.13.2 Environmental Consequences of the Proposed Action

4.13.2.1 Noise

Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, which produce noise impacts to commercial fishing operations and targeted species include seismic surveys, platform installation, drilling, and vessel traffic. Noise from these activities may temporarily displace targeted fish species (Section 4.6) and affect catch rates of commercial fishermen. Impacts from the use of airguns in seismic surveys may depend on the species involved (e.g., benthic versus pelagic). For example, inshore and groundfish species that are closely associated with the seafloor are not easily displaced from their home area (Wardle et al., 2001). Seismic surveys might directly cause temporary disturbance and dispersal of fish, which may reduce purse seine and gillnet salmon harvests in a local area. 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., 1998; Engås et al., 1996; Pearson et al., 1992). Generally, seismic surveys are short-term and localized operations and fish that are displaced are likely to backfill the surveyed area in a matter of hours; impacts on fishing operations would be brief. However, if these short-term and localized impacts occur in areas where a time limited fishery operates, the adverse effects on commercial fishers could be magnified. For example, the drift gillnet salmon fishery, which operates only on Mondays and Thursdays from mid-June to mid-August, could see decreased catch of commercial fishers due to the displacement of targeted species from the fishery grounds. Drilling and vessel noises are unlikely to affect commercial fishing because they either occur on a platform and out of the area targeted by fishers, as with drilling, or they are highly localized, short-term, and transitory, as with vessel noise.

4.13.2.2 Disturbance

Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, may disturb commercial fishing operations through space-use conflicts with oil and gas operations and presence of drilling structures. Potential effects of platform construction and operations would be highly localized but would occur throughout the life of the E&D Scenario, which spans 36 years. Pipeline and platform construction may temporarily impact commercial fishing if it occurs during the fishing season and targeted species are affected (Section 4.6). Equipment and vessels, like platform movement or seismic surveys, can entangle commercial fishing gear (e.g., longlines) or impact the habitat of targeted species, and commercial fishers likely would be temporarily excluded from the local area during construction. During construction, pipelines can pose entanglement hazards for some types of fishing gear employed near the seafloor. Commercial fishers using the area near a production platform for transit or fishing may lose access to part of the fishing grounds to maintain a safe operating area around the platform. Following platform construction there could be some highly localized but long-lasting changes in fish densities and species diversity in the vicinity of platforms due to attraction of some invertebrate and fish species to new habitat (Section 4.6), which could be beneficial or adverse to both fish and commercial fisheries.

The disturbances on commercial fishing operations would be highly localized but would span multiple fishing seasons. Impacts to commercial fisheries and the success of residents who participate in these fisheries could affect multiple Cook Inlet region towns. New platform and pipeline locations would be identified on navigational charts, but because a relatively small area of Cook Inlet would be affected, interference with commercial fisheries is expected to be limited. Cooperation between the exploration industry and the commercial fishing industry regarding timing and location of operations could minimize these space-use conflicts.

4.13.2.3 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on commercial fishing are described in Section A-3.13 of Appendix A. Most accidental spills or spill drills would be small, localized, and have relatively limited impacts to commercial fishing activities. Small spills are not expected to persist long enough to result in fisheries closures or reduced market values of fisheries over the lifespan of the E&D Scenario and therefore are not expected to have an economic effect on the Cook Inlet commercial fishing industry. In contrast, a single large spill could depress numbers of fish in subpopulations of commercially important species. 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 during peak salmon fishing could result in severe impacts to commercial fishing and major losses of income for commercial fishers. The occurrence of a large spill in Cook Inlet could result in an economic loss to the commercial fishing industry of approximately $9 to $43 million per year for 2 years (BOEM, 2016a; Cohen, 1993). The impacts of a large spill could be widespread, long-lasting, and would require spill response and cleanup, which itself can affect target species and commercial fishing gear through use of dispersants and mechanical recovery methods (see Section A-3.13, Appendix A). As with most small spills, a gas release and the resulting explosion would not exist long enough to close a fishery. 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.

4.13.2.4 Conclusion

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 is completed. Some impacts, as from new habitat creation, could be beneficial or adverse for fishery resources. Disturbance or displacement of fishing activities is expected to be highly localized. Generally, these impacts are minor, although in already time-limited fishing operations such as salmon gillnetting, impacts could be moderate due to the severity of the space-use conflict. Accidental small spills that may occur are unlikely to have an effect on commercial fishing. A large spill would affect only a small proportion of a given fish population within Cook Inlet but may damage fishing gear and could cause a fishery to be closed for an entire season or more, resulting in a 100 percent loss during the closure period. In general, most impacts are not anticipated to result in a clear, long-lasting change in the resource’s function. Overall, activities associated with the E&D Scenario, accidental small spills, and spill drills are likely to have minor to moderate impacts, but the occurrence of a large oil spill would result in major effects on commercial fishing due to potential changes in target fish stocks and impacts expected from cleanup efforts.

4.13.3 Environmental Consequences of the Alternatives

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

Potential impacts on commercial fishing under these alternatives would be somewhat decreased from those described for the Proposed Action. Excluding some OCS blocks from the Lease Sale, as with Alternative 3A, would preclude impacts from occurring in the mitigated area. Limiting seismic surveys and decreasing noise disturbances from platforms near major anadromous fish streams, as with Alternatives 3B and 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. This could prevent some displacement of commercially targeted species and may mitigate the effects to commercial fishers. Portions of the drift gillnet fishery may still be affected by seismic surveys. Under these alternatives, impacts to commercial fishing from activities associated with the E&D Scenario, accidental small spills, and spill drills would decrease from range of minor to moderate, to minor. The addition of a large spill would result in major effects on commercial fishing.

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

Potential impacts on commercial fishing under these alternatives would not differ substantially from those described for the Proposed Action. Excluding some OCS blocks from the Lease Sale, as with Alternative 4A, would preclude impacts from occurring in the mitigated area. Prohibiting drilling discharges within 1,000 m (3,280 ft) of critical sea otter habitat, as with Alternative 4B, is unlikely to affect catch rates or access to commercial fishing grounds. Under this alternative, impacts to commercial fishing from activities associated with the E&D Scenario, accidental small spills, and spill drills would remain minor to moderate. The occurrence of a large spill would result in major effects on commercial fishing.

4.13.3.3 Alternative 5 – Gillnet Fishery Mitigation

Potential impacts on commercial fishing under this alternative would be somewhat decreased from those described for the Proposed Action. Under this alternative, seismic surveys north of Anchor Point during drift gillnetting season are prohibited. With the implementation of this alternative, impacts on the commercial drift gillnet fishery would become negligible, as no space-use conflicts or impacts to the targeted fishery would occur from seismic surveys. 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. Other impacts may still occur as described in the analysis of the Proposed Action Alternative. Under this alternative, impacts to commercial fishing from activities associated with the E&D Scenario, accidental small spills and spill drills would decrease from a range of minor to moderate, to minor. The occurrence of a large spill would result in major effects on commercial fishing.

4.13.4 Cumulative Effects

Sources of cumulative impacts on commercial fishing include oil and gas operations, vessel traffic, oil spills, and climate change (Section 3.2). Most effects of the activities associated with the E&D Scenario would be temporary and are unlikely to substantially overlap in time and space with the actions described in the Past, Present, and Reasonably Foreseeable Future Activities (Section 3.2). However, where the actions listed in the Cumulative Assumptions do overlap, impacts from noise and disturbance may be expected, and are likely to be similar to the effects described in Section 4.13.2, including space-use conflicts. Appendix A considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. Large or chronic oil spills could have a cumulative impact on targeted fisheries in Cook Inlet through multi-season effects on commercial fishing. The effects described for activities associated with the E&D Scenario will add incremental impacts from oil and gas operations and seismic surveys described in Section 3.2. The mitigations proposed in the Gillnet Fishery Alternative could reduce additive cumulative impacts to commercial fishing related to seismic surveys over the lifespan of the E&D Scenario. These impacts would be localized and temporary, and unlikely to result in long-term disturbance or population-level impacts to commercially important fish species.

Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of fish and invertebrate communities in Cook Inlet, thereby affecting the commercial fishing industry. Elevated ocean temperatures and rapidly melting snowpack will likely continue having an effect on lower Cook Inlet commercial salmon fisheries (Shafte et al., 2017). As described in Section 4.6, regime shifts in fish and invertebrate communities of Cook Inlet may occur as a result of climate change. Some commercially important species may benefit from such changes to the prey base and increase in numbers, while other species may find the altered habitats less suitable and decrease in numbers.

Commercially important species may be affected by the activities described in the Past, Present, and Reasonably Foreseeable Future Activities section (Section 3.2). The incremental contribution of the activities associated with the E&D Scenario is unlikely to change the cumulative effects on commercial fisheries overall. However, the additive impacts associated with climate change and/or a large spill could have far-reaching effects on commercial fishing activities and fish populations and habitats in the area. Where impacts described in the Cumulative Assumptions may overlap over the life of the E&D Scenario, such as climate change or seismic surveys, the activities of the E&D Scenario would have no discernable additive or synergistic effect that was not already considered in the effects analysis. Although the cumulative impacts to commercial fisheries may be moderate, primarily due to climate change, the incrementally additive impact of the activities associated with the E&D Scenario in the context of these Cumulative Assumptions would be negligible.

4.14 Archeological and Historic Resources

4.14.1 Affected Environment

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest (30 CFR 550.105). Archaeological resources can be either pre-contact or historic. In North America, pre-contact resources pertain to the period before European contact with Native American and Alaska Native cultures; historic resources are from the period after European contact with these cultures. The Cook Inlet area has the potential to contain both onshore and offshore historic and pre-contact resources, including shipwrecks, aircraft, and archaeological sites potentially dating to approximately 8,000 before present (B.P.), and may date to 17,000 to 14,000 B.P. (Dixon, 2013; Klein and Zollars, 2008). However, archaeologists have not systematically surveyed most of the Cook Inlet area, particularly areas of the OCS. Not only is a basic inventory of resources limited, but so is the understanding of the decay processes, corrosion, and biotic relationships in cold water environments of Alaska (McMahan, 2007). Assessment of archeological resources at the lease sale level includes describing the types of resources that may be present and the potential of their presence or absence.

Potential for occurrence of archaeological resources and a summary of documented resources is presented in the FEIS for Lease Sale 244, which covers the same area as the Proposed Lease Sale Area for Lease Sale 258 (BOEM, 2016a, Section 3.3.8). Specifically, the information set forth in Section 3.3.8-1 and Figure 3.3.8-1 summarizes the methodology for identifying areas with potential for occurrence of pre-contact resources and the lease blocks with potential paleo-landforms. Additionally, Table 3.3.8-2 lists known historical shipwrecks located in the vicinity of the Proposed Lease Sale Area. The information in the specified section, figure, and table, as summarized here and with more specificity below, is incorporated by reference in support of BOEM's archaeological analysis for LS 258.

Submerged pre-contact sites may exist in areas of the Cook Inlet OCS that were once exposed above sea level and available to human occupation. The assessment of pre-contact resources considers the potential for such resources to have occurred, survived, and be recoverable within the Proposed Lease Sale Area. Discussion of potential for submerged pre-contact resources is provided in Section 3.3.8.1, pp. 3-195 to 3-198, of BOEM (2016a), which builds on the previous Prehistoric Resource Analysis completed for Cook Inlet Lease Sales 191 and 199 (MMS, 2003). BOEM identifies areas up to the 200-foot isobaths as those where submerged pre-contact sites could exist. Relic paleo-landforms in these areas may potentially retain evidence of early hunters and gatherers who once occupied the area. Figure 3.3.8-1 identifies a total of 100 whole or partial OCS blocks in the Proposed Lease Sale Area (which is the same as the Proposed Lease Sale Area for LS 258) as having potential for pre-contact archaeological resources. The identified OCS blocks are located mostly toward the western side of the Proposed Lease Sale Area, with some in central and eastern portions in the lower part of the Proposed Lease Sale Area.

Potential offshore historic resources include sites of ship and plane wrecks. Table 3.3.8-2 in BOEM (2016a) identifies 68 known wrecks, obstructions, archaeological sites, occurrences, or sites marked as “unknown” within or in the vicinity of the Proposed Lease Sale Area. Recorded ship losses include late nineteenth and early to mid-twentieth century vessels including numerous oil-, gas-, or diesel-powered screws, schooners, steamers, some barges and tugs, and other types of vessels. The number of recorded ship losses likely underrepresents total losses given the likelihood that sinkings occurred without survivors or witnesses to report the event. Even though many obstructions identified as “unknown” are eventually identified through investigation as modern trash or debris, those that have not been investigated cannot be ruled out as potentially submerged cultural or historic resources. Since publication of the LS 244 Final EIS, an additional potential shipwreck was identified in the Proposed Lease Sale Area (OHA, 2020).

Historic and pre-contact archaeological resources are documented onshore and along the coast. Sites are documented from systematic investigations along both the eastern shore and in areas of the western shore, including in Lake Clark National Park. Sites representative of several pre-contact cultures are documented throughout the Cook Inlet and Kodiak Island regions, as described in BOEM (2016a) Section 3.3.8.2, pp. 3-201 to 3-203. Historic resources include structures, artifacts, and other resources from early Russian exploration and establishment to European and American settlement and activity. The Alaska Heritage Resources Survey keeps a database of all known archaeological sites, including those on the National Register of Historic Places.

4.14.2 Environmental Consequences of the Proposed Action

Post-lease activities conducted as a result of LS 258, as described in the E&D Scenario, which could impact archeological and historic resources include ground or seafloor disturbance during platform installation, pipeline installation (both offshore and onshore), drilling, placement of equipment on the seafloor (e.g., nodes and cables for 3D surveys, anchors), and seafloor sampling.

Impacts to archaeological and historic resources from platform or pipeline installation and drilling would be localized and occur where an activity directly disturbs the ground or seafloor. Should an offshore activity come into direct contact with a shipwreck, it could physically damage the hull structure, resulting in permanent loss of archaeological data (e.g., information about how the ship was built). Direct contact with a shipwreck site could also damage or disturb artifacts, resulting in the loss of cultural information about the crew and cargo. In some instances, shipwrecks serve as gravesites of sailors lost at sea and disturbance of the site may result in disturbance to human remains. Impacts to historic aircraft would be analogous to shipwreck disturbances. Impacts to buried pre-contact sites may include destruction of artifacts and site features and disturbance of the stratigraphic context of the site. The placement of wells, platforms, or pipelines near archaeological resources can cause the surrounding seafloor to slump or may change the direction and intensity of local currents, scouring or exposing archaeological resources. This could cause deterioration or eventual loss of the resource and the information it contains. Ground disturbance within the onshore pipeline corridor has the potential for localized damage or disturbance to onshore archaeological resources.

The discharge of drilling muds and cuttings along with sediment displacement during pipeline trenching could bury an exposed resource. The impact would depend on the proximity of the discharge locations to an archaeological resource and how quickly the discharges disperse before reaching the seafloor. In high-energy environments such as Cook Inlet, relatively small amounts of drilling fluids and cuttings accumulate near well sites because deposits are quickly transported away by strong currents (Section 4.4).

The placement of equipment on the seafloor and seafloor sampling activities have the potential to damage any archaeological resources present. BOEM assumes one marine seismic survey during the 40-year E&D Scenario. The survey is anticipated to occur prior to geo- and shallow-hazard site surveys in which archeological sites can be identified. Therefore, if the survey is conducted using bottom-founded equipment, it could directly impact an unrecorded shipwreck or pre-contact site. Vessel anchoring would occur at any time during the E&D Scenario and could damage archaeological resources where anchors or anchor chains directly contact or drag/sweep across the seafloor. Geotechnical surveys could both affect and identify buried archaeological sites in all phases of the E&D Scenario. Seafloor sampling during geotechnical and shallow hazard surveys may include gravity/piston corers, shallow coring with a rotary drill, or grab or dredge sampling.

For all potential impacts discussed above, the intensity of impact may vary depending on the level of damage to a resource(s), the extent of impacts would be localized to the area of disturbance, and the duration would be long-term because archaeological resources are nonrenewable. However, because laws and regulations are in place to protect archaeological resources and other historic properties, BOEM expects to avoid most of the potential impacts described above, so their likelihood of occurrence is low.

In accordance with 30 CFR 550.194(a), where BOEM has reason to believe that an archaeological resource may exist in the lease area, it requires the lessee to provide an archaeological report with its EP or DPP. If that report suggests that an archaeological resource may be present, the lessee must either relocate its operations or conduct additional investigation that establish to BOEM's satisfaction that archaeological resources do not exist there or otherwise would not be affected. All post-lease sale activities would be subject to review under the National Historic Preservation Act (NHPA). Section 106 of the NHPA (Title 54, USC 306108) and regulations at 36 CFR Part 800 require federal agencies take into consideration the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation an opportunity to comment. Historic properties are those that are on or eligible for the National Register of Historic Places as described in 36 CFR 60. BOEM would review site-specific information prior to approving any lease-related activities with the potential to affect archaeological resources.

BOEM would consult with the State Historic Preservation Officer, Tribes, or other consulting parties, and the public to determine appropriate mitigation measures to protect said resources. BOEM's regulations continue to protect archaeological resources even after BOEM issues an approval and the lessee or operator commences post-lease activities. In accordance with 30 CFR 550.194(b), BOEM will notify the lessee or operator whenever it learns that an archaeological resource is likely to be present in a lease area and could be affected by proposed or ongoing activities. In such circumstances, the lessee or operator may not take any action that may adversely affect the archaeological resource until BOEM has prescribed how to protect the resource. Further, in accordance with 30 CFR 550.194(c), lessees and operators must immediately halt their operations and notify BOEM whenever they discover an archaeological resource on their lease or right-of-way. BOEM may then prescribe additional measures to protect pre-contact and historic resources.

4.14.2.1 Oil Spills Impact Summary

Effects of spills, spill drills, and spill response activities on archaeological resources are described in Section A-3.14 of Appendix A. Most spills would be small, localized, and have relatively limited impacts to archaeological resources. BOEM expects little to no impacts from small spills, because spilled oil or fuel is unlikely to come in contact with submerged or onshore archaeological resources. Oil spill drills are not expected to disturb the seafloor and would have little to no impacts. A large oil spill could result in long-lasting and widespread impacts to archaeological sites if resources are oiled or the biota colonizing sites were substantially altered. Impacts from a large spill and cleanup would depend on several factors including the location and size of the spill, decisions made during cleanup and response, and the uniqueness of the site. The greatest impacts from a large spill may be due to spill response and cleanup activities, which create opportunities for disturbances to resources through vandalism, or inadvertent damage from activities such as anchoring, or onshore activity. Impacts of spill cleanup and response would be long-term and localized or widespread. A large gas release could have long-term and localized or widespread impacts in the unlikely event of ignition occurring and damaging nearby resource(s).

4.14.2.2 Conclusion

Impacts to pre-contact and historic resources would range from none to localized, and therefore minor. BOEM would review site-specific information regarding potential archaeological resources prior to approving any lease-related activities with the potential to affect such resources, including placement of bottom-founded equipment or structures. Lessees would be required to survey for pre-contact and historic resources prior to disturbing areas where they may occur and avoid or mitigate impacts to identified sites. Overall, the impacts to archeological and historic resources from the E&D Scenario activities, accidental small spills, and spill drills would be negligible to minor. When potential impacts of a large spill including response and cleanup activities are considered, the expected impacts could become moderate.

4.14.3 Environmental Consequences of the Alternatives

Potential impacts on archaeological and historic resources under all action alternatives would not differ substantially from those described for the Proposed Action. It is expected that most impacts of routine activities on archaeological and historic resources would be avoided under any action alternative through compliance with Section 106 of the NHPA and 36 CFR 800, and BOEM's requirements at 30 CFR 550.194. These alternatives are not expected to change the likelihood or severity of impacts on archaeological resources evaluated for the Proposed Action. Overall, the impacts on archaeological resources would be negligible to minor for E&D Scenario activities, accidental small spills, and spill drills, and moderate when considering the addition of a large spill and spill response.

4.14.4 Cumulative Effects

Sources of cumulative impacts on archaeological resources include oil and gas activities, large oil spills, marine transportation, maintenance and expansion of ports and terminals, mining projects, fishing, scientific research, community development, and climate change. Potential cumulative impacts to archaeological resources range from destabilization and degradation of resources to physical damage or destruction, resulting in the loss of archaeological data. Impacts could occur from direct contact to resources, ground- or seafloor-disturbing activities, and burial or contamination.

Types of cumulative impacts from oil and gas activities would be similar to those described for the activities associated with the E&D Scenario. Offshore impacts in federal and state waters could result from activities including placement of exploration survey equipment, drilling and discharges, and platform and pipeline installation. Impacts from onshore oil and gas activities could occur through ground disturbances from gravel mining, construction of gravel roads and pads, and pipeline installation. Because oil and gas exploration and development in federal or state lands and waters would be subject to permitting requirements that include agencies' reasonable and good faith efforts (36 CFR 800.4(b)(1)) to identify and protect historic and archeological resources, most of the impacts would be mitigated to little or none. However, if a resource that is not identified prior to activities, and therefore is not protected, is damaged, that impact would be localized but permanent.

Large oil spills could occur in Cook Inlet from a variety of activities. Appendix A also considers the possibility of up to two additional large spills from sources other than those related to LS 258 post-lease activity. The types of impacts from oil spills and spill response on historic and archeological resources would be similar to those described for the activities associated with the E&D Scenario (Section 3.14, Appendix A). Large oil spills have potential to impact resources over a widespread area via direct contact, through persistent contamination of sediments, or during cleanup operations. Large spills could have severe impacts if resources are oiled, or sites are damaged during cleanup and important archaeological or historic information is lost.

Other activities that could contribute to cumulative impacts on archaeological resources include current and future seafloor and ground disturbances from residential and community development; marine traffic and port maintenance and expansion; fishing; scientific research; and infrastructure in support of mining projects. Residential and community development has potential to expose previously buried or otherwise inaccessible archaeological resources to potential looting or vandalism. Seafloor disturbance from vessel traffic could occur from anchoring or dredging of shipping channels and ports. Anchoring could occur throughout Cook Inlet, while dredging of shipping channels and around ports would be confined to specific areas. Some fishing techniques that use gear deployed on or near the seafloor such as dredging, bottom trawling, or placement and removal of pots, have potential to contact and possibly damage archaeological resources. Seafloor sampling activities related to scientific research also have potential to contact resources. These activities would not necessarily require federal approval; therefore, measures to identify and avoid archaeological resources may not be employed. Within the scope of the entire Cook Inlet area, localized bottom disturbances from anchoring, fishing, or scientific research activities are unlikely to contact a resource, but if impacts did occur, they would be localized and long-term.

Installation of pipelines and shoreline infrastructure for the mining projects described in Section 3.2 would result in seafloor and ground disturbance, but these activities would be subject to permitting requirements that include identification and protection of archaeological resources. Onshore, ground disturbance for community development or road construction projects would have potential to impact historic and archaeological resources, but site clearance surveys and avoidance of identified resources would minimize impacts. Overall, activities subject to permitting requirements would result in impacts that range from little to none to localized but long-term.

Changing environmental conditions have potential to affect both on- and offshore historic and archaeological resources. Storm surge, shoreline erosion, sea level rise, altered hydrology, snow melt, and glacier retreat or advances all have the present and reasonably foreseeable future effect of destroying, flooding, or altering the context and integrity of historic and archaeological resources (Hollesen et al., 2018; Rockman, 2015). Impacts on archaeological and historic resources include site modification that could occur as a result of shoreline erosion, and sea level rise that could destroy, flood, bury, or expose a historic site or artifact. Newly exposed sites can be vulnerable to vandalism or unauthorized collection of artifacts (Hollesen et al., 2018). In addition, changes in biological communities and water chemistry resulting from ocean acidification could disrupt the equilibrium in which archaeological resources currently exist, which could lead to deterioration. These impacts are expected to continue into the foreseeable future and many previously unidentified and undocumented resources, and their associated historic and archaeological information, could be lost. The overall effect of impacts from climate change to archaeological resources would be long-term and widespread and could be severe if important archaeological information is lost through destruction of resources and sites.

Many potential cumulative impacts would be mitigated or avoided by safeguards already in place through the NHPA and state and federal permitting processes. Cumulative impacts would be negligible to minor for most activities. Activities in the E&D Scenario are not expected to contribute measurably to cumulative impacts on archaeological resources because most impacts would be avoided or mitigated or would be localized. Large oil spills have potential for unavoidable or unmitigated impacts to resources over a widespread area. Impacts resulting from climate change can be expected to occur over the next several decades. Cumulative impacts to historic and archaeological resources would be potentially major if numerous sites face damage from large oil spills and/or climate change.

4.15 Environmental Justice

4.15.1 Affected Environment

Environmental justice (EJ) 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" (EPA, 2014). Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs federal agencies to consider EJ as part of their mission. On January 27, 2021 EO 12898 was amended by EO 14008, Tackling the Climate Crisis at Home and Abroad. EO 12898 requires an evaluation in the EIS as to whether an action would have disproportionately high and adverse human health and environmental effects on a minority population, a low-income population, or Indian tribe (CEQ, 1997).

Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent 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). Federal agencies are also directed to consider minority populations and Indian tribes with differential patterns of subsistence consumption of fish and wildlife (CEQ, 1997).

The Alaska statewide population is approximately 14 percent American Indian and Alaska Native. For the KPB, the population of American Indian and Alaska Native peoples is approximately 7 percent (ADLWD, 2020b). Table 4-19 identifies racial composition of communities in the Cook Inlet region that have a high percentage of minority population compared to the borough and state. These communities have a meaningfully higher percentage of Alaska Native Peoples living there than the KPB as a whole, and all but one, Ninilchik, have a meaningfully higher percentage of Alaska Native peoples living there than the SOA as a whole. Moreover, for all but two of these communities, the minority population exceeds 50 percent of the total community population. Therefore, these communities qualify as EJ communities based on their racial/ethnic minority composition. The identified EJ communities also display disproportionately high consumption patterns of fish and wildlife and other subsistence resources (Section 4.11). In addition, communities farther from the Proposed Lease Sale Area that could be impacted by a large oil spill and that BOEM considers EJ communities based on high percentages of Alaska Native Peoples (ADCCED, 2020; USCB, 2010) and subsistence consumption patterns, include Chignik Bay, Chignik Lagoon, Chignik Lake, Perryville, Ivanof Bay, Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions.

Table 4-19: Population and Minority Composition of Cook Inlet Environmental Justice Communities

Community	Population	American Indian or AK Native (%)	White (%)	Two or More Races (%)	Asian (%)	Black or African American (%)	Native Hawaiian, Pacific Islander (%)
Nanwalek	280	78.24	5.56	13.43	0.46	0	2.31
Ninilchik	821	11.49	78.46	8.75	1.31	0	0
Port Graham	180	82.23	8.63	8.63	0	0.51	0
Seldovia Village	185	25.71	58.29	8.57	6.29	0	1.14
Tyonek	143	80.55	2.39	16.38	0	0	0.68

Source: ADCCED, 2020.

4.15.2 Environmental Consequences of the Proposed Action

The Alaska Native communities identified above as EJ communities have the potential to be affected by post-lease activities that may result from LS 258 as described in the E&D Scenario due primarily to their reliance on local natural resources for health, nutrition, social organization, cultural identity, and well-being. BOEM initiated opportunities for Government-to-Government tribal consultations to include EJ concerns through letters and follow-on contacts to Tribes in the Cook Inlet region whose members could be affected by activities related to proposed LS 258. Details of the consultation efforts and contacted communities are provided in Sections 5.2.1 and 5.2.2. Seldovia Village Tribe provided written comments that expressed concerns for Cook Inlet beluga whale and northern sea otter populations and identified areas in state and OCS waters that are important for commercial, recreational, and subsistence fishing.

For the purposes of EJ analysis, in accordance with EO 12898, any major adverse impacts to a resource on which an EJ community depends would be considered disproportionately high and adverse; impacts lower than major would not. Analysis of the post-lease activities described in the E&D Scenario found no major (i.e., high and adverse) impacts for E&D activities or small spills for subsistence activities and harvest patterns, air quality, water quality, or the biological resources harvested for subsistence. Therefore, no disproportionately high and adverse impacts to EJ communities are expected to result from the E&D Scenario activities, small spills, and spill drills.

A large oil spill could have disproportionately high and adverse effects to EJ communities because it could have major adverse impacts to subsistence activities and harvest patterns (Sections A-3.9 and A-3.10, Appendix A). These impacts would disproportionately affect EJ communities due to their distinct cultural practices and subsistence ways of life. In addition, moderate to major impacts on some marine and coastal resources (Sections A-3.2 through A-3.5, Appendix A) would also impact EJ communities that rely on a healthy marine system to support their way of life. BOEM anticipates these impacts would disproportionally affect EJ 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-EJ communities in the Proposed Lease Sale Area.

4.15.3 Environmental Consequences of the Alternatives

Potential impacts on EJ communities under all the action alternatives would not differ substantially from those described for the Proposed Action. Analysis of the action alternatives for subsistence, air quality, water quality, and biological resources found no major (i.e., high and adverse) impacts related to activities described in the E&D Scenario or small spills. Additionally, impact conclusions for a large spill did not change for the above-listed resources for the action alternatives. Therefore, no disproportionately high and adverse impacts to EJ communities are expected to result from the E&D Scenario activities, small spills, and spill drills, but a large oil spill could have disproportionately high and adverse effects.

4.15.4 Cumulative Effects

EJ communities in the Cook Inlet Region rely on local resources to maintain community resiliency, health, and social and cultural well-being, and could be affected by cumulative impacts on air and water quality, biological resources, subsistence activities and harvest patterns, and economy. Cumulative impacts on these resources are discussed in their respective sections (Sections 4.3 through 4.9, 4.11, and 4.12), and range from negligible to moderate from past, present, and RFFAs, but could increase to major, primarily through impacts from climate change. Moderate to major cumulative impacts on populations of fish and wildlife are anticipated through effects of climate change (Sections 4.6, 4.7, 4.8, and 4.9). Those resources with major impacts would disproportionately affect EJ communities in the region that rely on fish and wildlife resources. Climate change is raising environmental justice issues in Alaska and around the globe (Levy and Patz, 2015; Trainor et al., 2007). Changes in drought and fire frequency and intensity, flooding and coastal erosion, shifts in biological species composition, and community infrastructure are expected to affect Cook Inlet Region communities, and many impacts could disproportionately affect EJ communities.

4.16 No Action Alternative

Under the No Action Alternative, Cook Inlet Lease Sale 258 would not be held, and no exploration, development, or production activities associated with this particular sale would occur. If the estimated 0-162.7 MMbbls of oil and 229.5–290.7 Bcf of natural gas were not produced, there would be no chance of oil spills or gas releases occurring from wells, platforms, or pipelines. Potential impacts from the Proposed Lease Sale, including OCS oil and gas activities described in the E&D Scenario (Section 4.1) would be delayed or eliminated. Potential economic benefits including direct and indirect wage earnings, taxes, and royalties collected by the SOA and the federal government would not occur; however, Cook Inlet physical, biological, and socioeconomic resources would continue to be exposed to potential impacts from any ongoing activities in SOA and federal waters.

4.17 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.

- Air Quality: Impacts from surveys, exploration, and production operations. Impacts resulting from platforms would dissipate as the emissions mix with the surrounding air masses.
- Water Quality: Increase in TSS from construction activities; discharge of exploration and delineation well rock cuttings and fluids, and other operational discharges.
- Coastal and Estuarine Habitats: Impacts from seafloor disturbance activities, discharges, pipeline landfalls, and onshore construction.
- Fish and Invertebrates: Impacts from addition of drilling platforms or presence of vessels in the region would be limited to the immediate vicinity of the structure or activity.
- Birds: Vessel operations and marine habitat alterations would occasionally displace some birds and interfere with foraging. Bright artificial lighting and gas flaring from platforms and vessels would annually cause some collisions of migrating birds from widespread populations.
- Marine Mammals: Impacts of noise on marine mammals could lead to individual animals avoiding the most heavily ensonified areas, particularly around seismic surveys and pile-driving. Long-term disturbances to marine mammal habitat could occur with the installation of production platforms and pipelines; platforms could have a positive impact by increasing food availability.
- Terrestrial Mammals: Impacts would be localized to the site of the project infrastructure offshore, geographically distant from terrestrial habitats. Onshore pipeline construction and disturbance will have short-term and localized impacts.
- Recreation, Tourism, and Sport Fishing: Impacts will primarily arise from disturbance in the form of space-use conflicts. Access to some sport fishing areas may be temporarily limited and some short-term displacement of populations of sport species such as salmon and halibut may result.
- Communities and Subsistence: Short-term and localized impacts from effects on the availability of subsistence resources and space-use conflicts.
- Economy: Size and duration of impacts are tied to the size of a resource discovered. Economic impacts to Alaska would range from negligible to minor, while the KPB would experience negligible to moderate effects.
- Commercial Fishing: Temporary displacement of fishery resources and fishing activities from localized areas could occur as a consequence of noise and activities associated with construction

during development. For some fisheries, such as salmon gillnetting, impacts could be moderate due to the severity of the space-use conflict.

- Archaeological and Historic Resources: Impacts to pre-contact and historic resources would range from none, to localized and therefore minor.

4.18 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 and production, and decommissioning activities would entail some impacts to nearly all resource categories analyzed. Most impacts 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 assumptions and mitigation measures described in Chapter 3 (Section 3.4) and are not expected to adversely affect long-term productivity.

Oil and natural gas production would yield short-term economic benefits, but the resulting GHG emissions may contribute to global changes in climate, including long-term impacts to global productivity (Section 3.2). 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 a changing climate could affect long-term productivity of marine and coastal environments.

4.19 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. Irreversible and irretrievable effects could occur only as a result of exploration, development, production, and decommissioning activities. Each of these activities occurs at a future stage of the OCSLA process and would require additional NEPA review before being authorized.

CHAPTER 5: CONSULTATION, COORDINATION, AND PREPARERS

5.1 Cooperating Agencies

BOEM is the lead agency for the preparation of this EIS. Following the guidelines at 40 CFR 1501.6 and 1508.5 from the CEQ, BOEM invited qualified government entities to become cooperating agencies for the preparation of the proposed LS 258 EIS. BSEE participated as a formal cooperating agency on the Draft EIS. Other key agencies that provided input included the NPS and the SOA's Governor's office. BOEM will continue to coordinate with other federal and state agencies throughout the NEPA process.

5.2 Consultation

5.2.1 Tribal Consultation

EO 13175 established regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, to strengthen United States government-to-government relationships with Indian tribes (including Alaska Native tribes and communities), and reduce the imposition of unfunded mandates upon tribes when developing federal policies with tribal implications. The order requires the head of each agency to designate an official "with principal responsibility for implementation" of the order. USDOI has an established Tribal Consultation Policy.

Secretarial Order (SO) 3317 updated the USDOI's policy on consultation with Indian tribes in compliance with EO 13175. In summary, SO 3317 states that USDOI officials must demonstrate a meaningful commitment to consultation "by identifying and involving Tribal representatives early in the planning process," and that consultation aims to create effective collaboration emphasizing "trust, respect, and shared responsibility. ..."

To fulfill its consultation obligations, BOEM has initiated and remains available for Government-to-Government tribal consultations through letters and follow-up contact with Tribes whose members could be affected by activities related to proposed LS 258 including:

- Native Village of Nanwalek
- Native Village of Port Graham
- Seldovia Village Tribe
- Ninilchik Traditional Council
- Kenaitze Indian Tribe (Indian Reorganization Act (IRA))
- Salamatof Tribal Council
- Knik Tribal Council
- Chickaloon Traditional Village Council
- Native Village of Tyonek (IRA)
- Cook Inlet Tribal Council

5.2.2 Government to ANCSA Corporation Consultation

On August 10, 2012, the USDOI issued the Policy on Consultation with ANCSA Corporations. In this policy, USDOI restated a provision of ANCSA requiring "[t]he Director of the Office of Management and Budget [and all federal agencies] shall hereafter consult with Alaska Native corporations on the same basis as Indian tribes under EO 13175." The policy "distinguishes the federal relationship to ANCSA corporations from the government-to-government relationship between the federal government and federally recognized Indian Tribes... and [states that] this Policy will not diminish in any way that relationship...”.

To fulfill its consultation obligations, BOEM has offered and remains available for Government-to-ANCSA corporation consultations through letters and follow-on contacts to ANCSA corporations potentially affected by activities related to the proposed LS 258, including:

- English Bay Corporation
- Port Graham Corporation
- Kenai Natives Association, Incorporated
- Ninilchik Natives Association, Incorporated
- Chickaloon-Moose Creek Native Association
- Salamatof Native Association, Incorporated
- Eklutna, Incorporated
- Seldovia Native Association, Incorporated
- Tyonek Native Corporation
- Cook Inlet Region, Incorporated
- ANCSA Regional Association

5.2.3 Section 7, Endangered Species Act Consultation

The ESA (16 USC § 1531) provides a program for the conservation of threatened and endangered plants and animals and the ecosystems on which they depend. Section 7(a)(2) of the ESA requires each federal agency to ensure that any action that it authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. With respect to this proposed lease sale, BOEM is consulting with USFWS and NMFS (the “Services”) concerning potential impacts to listed species and their designated Critical Habitat. For ESA consultation on proposed lease sales in Alaska, BOEM specifically requests incremental Section 7 consultations. Regulations at 50 CFR 402.14(k) allow consultation on part of the entire action as long as that step does not violate Section 7(a)(2); there is a reasonable likelihood that the entire action will not violate Section 7(a)(2); and the agency continues consultation with respect to the entire action, obtaining a Biological Opinion for each step. Accordingly, at the lease-sale stage, BOEM evaluates the early lease activities (e.g., 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 complete Section 7 consultation with the Services prior to issuing any new leases and would then reinitiate consultation as needed.

5.2.4 Essential Fish Habitat Consultation

The Magnuson-Stevens Fishery Conservation and Management Act (as amended) requires federal agencies to consult with NMFS regarding actions that may adversely affect designated Essential Fish Habitat (EFH). BOEM is currently preparing an EFH assessment that will identify any adverse effects to designated EFH from potential oil and gas exploration activities in the Proposed LS 258 Area. This assessment will be provided to NMFS prior to releasing a Final EIS.

5.2.5 Section 106, National Historic Preservation Act Consultation

Section 106 of the NHPA (Title 54, USC 306108) and regulations at 30 CFR 800 *et seq.* require federal agencies take into consideration the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation an opportunity to comment. Consultation under Section 106 would include the Alaska State Historic Preservation Office (SHPO), as well as Tribes and other interested parties. BOEM recognizes that a lease sale constitutes an undertaking under Section 106 of the NHPA but is not the type of activity that has the potential to cause effects on historic properties, and thus would not require formal SHPO consultation. Subsequent project- and site-specific consultations will occur 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.

5.3 List of Preparers and Supporting Staff

Table 5-1: List of Preparers and Supporting Staff

Name	Position Title	Contribution
Michael Bradway	Regional Supervisor, Resource Evaluation	E&D Scenario Development
Meghan Cornelison	Social Scientist	Communities and Subsistence; Archaeological and Historic Resources; Environmental Justice; NHPA Section 106 Consultation
Christopher Crews	Wildlife Biologist	Marine Mammals
Maureen de Zeeuw	Wildlife Biologist	Birds
Lorena Edenfield	Fish Biologist; Chief, Environmental Analysis Section I, Acting	Fish and Invertebrates; Commercial Fishing; Essential Fish Habitat Consultation
Lisa Fox	Environmental Protection Specialist	NEPA Coordinator; Document Development and Review; Environmental Analysis Section I, Acting
Shane Gray	Wildlife Biologist	Terrestrial Mammals; Recreation, Tourism, and Sport Fishing
Pamela Grefsrud	Wildlife Biologist	Water Quality; Coastal and Estuarine Habitat
Timothy Harper	Economist	Economy
Amee Howard	Chief, Environmental Analysis Section I, Acting	Lease Sale 258 Project Manager
Kimberly Klein	Wildlife Biologist	ESA Consultation; BA Preparation
Michael Lu	Petroleum Engineer	E&D Scenario Development
Virgilio Maisonet-Montanez	Physical Scientist, BLM	Air Quality
Frances Mann	Chief, Environmental Analysis Section II	Document Review
Gail Morrison	Geographer	GIS Map Production
Charles Paris	Economist	Air Quality Modeling; Lifecycle GHG Emissions
Craig Perham	Wildlife Biologist	ESA Consultation; BA Preparation
Gwendolynn Robinson	Information Specialist	Database Management; Scoping Support
Caryn Smith	Oceanographer	OSRA Coordinator; Oil Spill Scenario
Chase Stoudt	Oceanographer	Project Support; Document Review
Shannon Vivian	Technical Writer/Editor	Document Compilation; Technical Editing; Publication
Eric Wolvovsky	Meteorologist, Headquarters	Air Quality Modeling; Lifecycle GHG Emissions

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30 CFR 550.211, What Must the EP Include?

30 CFR 550.227, What Environmental Impact Analysis (EIA) Information Must Accompany the EP?

30 CFR 550.241, What Must the DPP or DOCD Include?

30 CFR 550.261, What Environmental Impact Analysis (EIA) Information Must Accompany the DPP or DOCD?

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APPENDIX A

Oil Spills and Gas Release Analysis

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Acronyms and Abbreviations

AAC	Alaska Administrative Code
API	American Petroleum Institute
bbl	barrel(s)
Bcf	billion cubic feet
Bbbl	billion barrels
BOEM	Bureau of Ocean Energy Management
BS	boundary segment
BSEE	Bureau of Safety and Environmental Enforcement
C_2H_6	ethane
CH	critical habitat
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
DOT	Department of Transportation
DPS	Distinct Population Segment
E&D	exploration and development
EIS	Environmental Impact Statement
EJ	Environmental Justice
EPA	U.S. Environmental Protection Agency
ERA	environmental resource area
ESA	Endangered Species Act
ESI	environmental sensitivity index
EVOS	*Exxon Valdez* Oil Spill
FEIS	Final Environmental Impact Statement
G&G	geological and geophysical
GIUE	Government Initiated Unannounced Exercise
GLS	grouped land segment
IBA	important bird area
km	kilometer(s)
LA	launch area
LOWC	loss of well control
LS	land segment
mi	miles
mm	millimeter(s)
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NWR	National Wildlife Refuge
O_3	ozone
OCS	Outer Continental Shelf
OSRA	oil spill risk analysis
OWM	oil weathering model
PAH	polycyclic aromatic hydrocarbon
PL	pipeline
PM_{10} and $PM_{2.5}$	particulate matter (equal to or less than 10, and equal to or less than 2.5 micrometers diameter)
SINTEF	The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology
SO_2	sulfur dioxide
SUA	subsistence use area
TAH	total aromatic hydrocarbon
TAqH	total aqueous hydrocarbon
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service

VLOS	very large oil spill
VOC	volatile organic compound

Accidental Oil Spills and Gas Release Information and Analyses

The U.S. Department of the Interior (USDOI), Bureau of Ocean Energy Management (BOEM) analyzes hypothetical oil spills, a gas release, spill drills, and response activities and their potential impact to physical, biological, sociocultural, and economic resources in relation to lease sales it holds on the Outer Continental Shelf (OCS). These analyses inform the overall assessments of environmental consequences of offshore oil and gas exploration, development, and production that may occur in the future as a result of proposed Lease Sale 258 (LS 258) in Cook Inlet, Alaska. Section A-1 provides the background and framework information for the analyses. Section A-2 provides supporting information used to derive the Oil Spills and Gas Release Scenario (Spill Scenario) in Section 3.1 of this Environmental Impact Statement (EIS). Section A-3 provides analysis of impacts on resources, and Chapter 4 of this EIS summarizes these impacts by resource.

A-1 Background and Framework for Analysis

Oil spills or gas releases have varying potential to occur from activities associated with offshore oil and gas exploration, production, or transportation in or adjacent to the Proposed Lease Sale Area. BOEM has conducted a formal oil spill and gas release analysis, which starts by using the Exploration and Development Scenario (E&D Scenario) (this EIS, Section 4.1) to develop oil spill and gas release assumptions. The E&D Scenario provides one hypothetical view of how post-lease oil and gas exploration, development, production, and ultimately decommissioning could proceed as a result of LS 258. The E&D Scenario provides a framework from which BOEM can analyze the impacts of the Proposed Action, which does not by itself authorize any particular activity. The E&D Scenario considers a range of production that could occur long-term as a result of LS 258. The E&D Scenario estimates, at the high end, production of up to 192.3 million barrels of oil and 301.9 billion cubic feet (Bcf) of gas. BOEM then uses technical information and historical data about oil spills and gas releases, modeling results, statistical analysis, and professional judgment to estimate information about oil spills and gas releases (detailed in Section A-2). The impact analyses are based on a set of assumptions about the number, volume, and types of spill or release, and their weathering—collectively referred to as the Spill Scenario (this EIS, Section 3.1). Additionally, the *Oil Spill Risk Analysis* (OSRA) report (Ji and Smith, 2021) informs the analysis of a large oil spill.

Oil spills are considered accidental events, and the Clean Water Act and the Oil Pollution Act include both regulatory and liability provisions that are designed to reduce damage to natural resources from oil spills. Because large spills and gas releases are an important concern to stakeholders, and no one can estimate the future perfectly, BOEM assumes a large spill or gas release will occur and conducts a large oil spill and gas release analysis for development and production activities. This conservative analysis addresses whether such spills could cause serious environmental harm and informs the decision maker of potential impacts should an unlikely large spill or gas release occur. Assuming more large spills or gas releases than the estimated mean number helps to ensure that this EIS does not underestimate potential environmental effects.

The Spill Scenario assumes:

- Approximately 410 small spills (spills less than (<) 1,000 barrels (bbl)) of crude, condensate, or refined oil occur over the life of post-lease activities that may result from LS 258, which the E&D Scenario has estimated to last 40 years.
- One large crude, condensate, or refined oil spill (greater than or equal to (≥) 1,000 bbl) over the 32 years of oil and gas development and production activities described in the E&D Scenario. This analysis assumes a large spill volume of 3,800 bbl.

- One large natural gas release (offshore or onshore), over the 32 years of gas production described in the E&D Scenario. This analysis assumes a gas release of 20–30 million cubic feet over one day.
- To ensure impacts of a spill are not underestimated, the impact analysis does not incorporate a potential volume reduction from cleanup and response; the entire spill or release volume(s) is analyzed. The impact analysis does incorporate BOEM estimates for impacts to resources from cleanup and response.

Very large oil spills and gas releases are very low probability, high impact events. Although very unlikely (frequency of spill exceeding 120,000 bbl is >0.00001–< 0.0001 per well) and not reasonably foreseeable, BOEM considered a hypothetical long duration loss of well control resulting in 120,000 bbl of oil and released gas. For an analysis of a very large oil spill (VLOS) (≥120,000 bbl) and gas release, which is not reasonably foreseeable as a result of Cook Inlet OCS oil and gas activities, refer to Section 4.12, Impacts of a Very Large Oil Spill and Appendix A, Section A-7, Very Large Oil Spill in *Cook Inlet Planning Area Oil and Gas Lease Sale 244 in the Cook Inlet, Alaska Final Environmental Impact Statement* (BOEM, 2016). The Lease Sale 244 Final Environmental Impact Statement (FEIS) includes a discharge analysis methodology, general effects of oil and gas on physical, biological, social, and economic resources, and impacts to resources from the initial loss of well control event to long-term recovery. BOEM analysts reviewed the analysis and determined it still provided decisionmakers with a robust analysis of the potential impacts associated with low probability very large oil spills for oil and gas activities on the OCS (CEQ, 2010).

Once oil or gas enters the environment, it begins to degrade through physical, chemical, and biological processes referred to as weathering. The report, *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* (BOEM, 2020; Section 4.1) details the major oil weathering processes. These include spreading, evaporation, dispersion, dissolution, emulsification, microbial degradation, photochemical oxidation, and sedimentation to the seafloor or stranding on the shoreline (Afenyo et al., 2016; Allen, 1980; Boehm, 1987; Lee et al., 2015; Payne et al., 1987; Tarr et al., 2016; Wiens, 2013). These processes are complex and act simultaneously as well as independently. Weathering processes affect various oil or gas constituents at differing rates ranging from hours to decades (Farrington, 2014). Spreading, evaporation, dispersion, emulsification, and dissolution are most relevant during the early stages of a spill, while photo-oxidation, sedimentation, and biodegradation are longer-term processes. Evaporation removes the more volatile, highly soluble, and toxic lower molecular weight components and leaves behind the less soluble, higher molecular weight components with lower toxicity potential (Di Toro et al., 2007). Along with the weathering processes, the physical environment, depth of release, spill volume, and unique composition and physical properties of oil determine the oil's fate in the environment (NRC, 1985, 2003a, 2014). Specific oil weathering estimates for assumed oil types and volumes are presented in Sections A-2.1.3 and A-2.2.2.

Impacts to resources from oil spills or gas releases may be prevented or mitigated through oil spill prevention, preparedness, and response measures. The report, *Oil Spill Preparedness, Prevention, and Response on the Alaska OCS* (BOEM, 2019), provides information on oil spill prevention and preparedness requirements, including spill drills, and response strategies that could be employed on the OCS. From that report, Section 5.3.4, Bureau of Safety and Environmental Enforcement (BSEE) Oil Spill Response Plan Drills, and Section 7, Description of Potential Response Actions, are incorporated by reference and summarized here. The report is available on BOEM's website at https://www.boem.gov/BOEM-2019-006/. BSEE periodically commences both announced and unannounced exercises to test the operator's spill response preparedness. Government Initiated Unannounced Exercises (GIUEs) are typically less than 8 hours in duration but can last longer and include exercising a response plan, tracking and surveillance, and countermeasures in localized areas. Response and cleanup actions would be implemented in the event of an oil spill or gas release and could require multiple technologies. Technologies and response efforts include surveillance and monitoring, waste management, wildlife response, source containment, and both mechanical and non-mechanical countermeasures. Mechanical recovery includes the physical removal of oil from the sea, ice, or shoreline surface typically accomplished using containment booms, skimmers, direct suction, heavy equipment, sorbents, temporary storage, separation, and disposal. Non-mechanical countermeasures to combat an oil spill include dispersants, surface collecting agents, and in-situ burning.

A-2 Oil Spills and Gas Release Information, Models, and Estimates

This section discusses the information and methods used to derive the Spill Scenario (this EIS Section 3.1). Oil spills are divided into two general phases of operations and two spill-size categories. These divisions reflect a difference in how the information about the spills or releases is derived and used. The two general activity categories considered in oil spill analysis are:

- Exploration and delineation
- Development, production, and decommissioning

The two spill-size categories considered in oil spill analysis are:

- Small spills: those <1,000 bbl, do not persist on the water long enough to follow their path in a trajectory analysis.
- Large spills: those ≥1,000 bbl, meaning that 1,000 bbl is the minimum size for a large spill. A large spill persists on the water long enough to follow its path in a trajectory analysis.

BOEM considers three oil types—refined, crude, and condensate—and natural gas, which is primarily made up of methane (CH_4) and ethane (C_2H_6).

A-2.1 Small Oil Spills

Small spills, although accidental, are relatively routine. Accidental small spills are likely to occur over the life of the exploration and development activities, and operators follow routine spill prevention and response measures. The majority of small spills could be contained on a vessel or facility. Generally, if a small spill does reach water, refined fuels would evaporate and disperse in a few days, but small crude oil spills take longer. Further, those spills reaching the water may be contained by booms or absorbent pads.

A-2.1.1 Exploration

Exploration includes both geological and geophysical (G&G) activities (marine seismic, geotechnical, and geohazard surveys) and exploration and delineation drilling activities. Small spills during exploration are likely to be refined oil products such as lube oil, hydraulic oil, gasoline, or diesel fuel.

A-2.1.1.1 Geological and Geophysical Activities

BOEM estimates small refined spills occur from vessels during G&G activities, but large crude and diesel fuel spills do not. This is based on a review of potential fuel transfer discharge volumes and on the historical oil spill occurrence data for the Alaska OCS and adjacent state waters.

The estimated offshore vessel transfer spill size ranges from <1–13 bbl (BOEM, 2012b, 2013; BOEMRE, 2010a, b). The <1 bbl is the estimated volume of diesel fuel resulting from an offshore vessel fuel transfer accident assuming the dry quick disconnect and positive pressure hose (spill prevention devices) function properly. Where a transfer hose ruptures and spill prevention devices fail, assumed discovery and response times are 30 seconds for rupture discovery and 30 seconds to stop the pump. Approximately 13 bbl spills on the vessel or reaches the environment during the 60-second interval.

To estimate the number and volume of spills, BOEM assumes each G&G activity transfers fuel and every other activity has a spill. This estimate is very conservative based on the fact that no offshore fuel transfer spills have been reported from G&G activities in the Alaska OCS. BOEM assumes 11 G&G site clearances are typical per survey. Site clearances include shallow hazard surveys and point samples. A total of 5 surveys were assumed including the deep penetrating marine seismic survey (this EIS Table 4-1). BOEM estimates 3 small spills from G&G activities. Ninety-nine percent of the time, transfer spill prevention devices function properly during offshore fuel transfers. For two G&G activities, BOEM assumes spill prevention devices function properly and spills could range from 0–<1 bbl each for a total of <2 bbl. It is assumed that one G&G activity has a spill prevention device malfunction and a spill up to 13 bbl. Finally, BOEM assumes that spills do not occur in the same time and space.

A-2.1.1.2 Exploration and Delineation Drilling Activities

To estimate spills from exploration and delineation drilling activities, BOEM reviewed potential discharges, historical oil spill and modeling data, and the likelihood of oil spill occurrence. No large crude or diesel oil spills are estimated to occur based on the following considerations:

- The low rate (3.58×10^{-3} per well drilled (Bercha Group, 2014)) of OCS exploratory drilling well-control incidents spilling crude oil.
- Since 1971, more than 14,000 OCS exploratory wells have been drilled, and one OCS crude oil spill from the Deepwater Horizon event (large/very large) has occurred during temporary abandonment (converting an exploration well to a development well).
- The number (8) of exploration wells in the E&D Scenario (this EIS, Section 4.1).
- No crude oil would be commercially produced from the exploration wells, and the wells would be permanently plugged and abandoned.
- All exploration spills on the OCS have been small.
- No large spills occurred while drilling 86 exploration wells to depth in the Alaska OCS from 1975–2019.
- Pollution prevention and oil spill response regulations and methods implemented since the Deepwater Horizon spill have reduced the risk of spills and diminished their potential severity (BOEM, 2012a, 2019; Visser, 2011).

Small spills are likely to occur during exploration and delineation drilling activities. Historical OCS exploration spill data suggest that the most likely cause of an oil spill during exploration would be operational, and the spill is likely be relatively small. A 50-bbl ultra-low sulphur diesel fuel transfer spill was chosen as one spill volume in the small spill category and 5 bbl was selected as the typical volume. The spill volumes were based on historical exploration spill sizes in the Beaufort and Chukchi Sea OCS (BOEM, 2015, Appendix A, Table A.1-2), which were all small; OCS oil spill data, which indicated that 99.7 percent of all OCS spills are <50 bbl (Anderson et al., 2012); and estimates of U.S. Coast Guard worst-case discharge, average most probable discharge, and maximum most probable discharge for exploration plans (Shell, 2011, 2012). To estimate the number and volume of spills, BOEM assumes that every exploration drilling activity (3) has an offshore transfer fuel spill. One drilling activity has a worst-case discharge of 50 bbl, and the rest have a maximum most probable discharge of 5 bbl for a total of 60 bbl. These spills are not assumed to occur in the same space and time.

A-2.1.2 Development and Production

To estimate the number of small crude and refined spills and volume, oil spill rates from *Update of Occurrence Rates for Offshore Oil Spills* (Anderson et al., 2012) and *2016 Update of Occurrence Rates for Offshore Oil Spills* (ABS 2016) were applied. Data for the years 1974–2015 was used for spills ≥1 bbl to <1,000 bbl (ABS, 2016) and 1996 through 2010 was used for spills <1 bbl (Anderson et al., 2012). Using the E&D Scenario production volume and the spill rates, a total of 405 small crude and refined oil spills (<1,000 bbl) were estimated during the 32-year oil and gas production life. BOEM multiplied the total number of spills in each size by the median volume to estimate the total oil spill volume.

A-2.1.3 Modeling Simulations of Oil Weathering

Table A1 summarizes the fate and behavior results of a 1-, 5-, 13-, and 50-bbl diesel fuel spill and a 125-bbl crude oil spill. Based on the Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology (SINTEF) Oil Weathering Model (OWM) calculations, a 50-bbl diesel fuel oil spill lasts less than three days in open water during summer or winter.

Table A1: Weathering of Small Diesel Oil Spills in the Cook Inlet OCS

Scenario Element	Summer Spill[1]					Winter Spill[2]						
Time After Spill in Hours	**6**	**12**	**24**	**48**	**72**	**6**	**12**	**24**	**48**	**72**	**96**	**120**
1 bbl Diesel												
Oil Remaining (%)	26	2	0	na	na	0	na	na	na	na	na	na
Oil Dispersed (%)	55	75	77	na	na	85	na	na	na	na	na	na
Oil Evaporated (%)	19	22	23	na	na	15	na	na	na	na	na	na
5 bbl Diesel												
Oil Remaining (%)	30	4	0	na	na	0	na	na	na	na	na	na
Oil Dispersed (%)	52	73	76	na	na	85	na	na	na	na	na	na
Oil Evaporated (%)	18	23	24	na	na	15	na	na	na	na	na	na
13 bbl Diesel												
Oil Remaining (%)	26	2	0	na	na	0	na	na	na	na	na	na
Oil Dispersed (%)	55	75	76	na	na	85	na	na	na	na	na	na
Oil Evaporated (%)	19	23	24	na	na	15	na	na	na	na	na	na
50 bbl Diesel												
Oil Remaining (%)	26	2	0	na	na	36	5	0	na	na	na	na
Oil Dispersed (%)	55	75	76	na	na	54	80	84	na	na	na	na
Oil Evaporated (%)	19	23	24	na	na	10	15	16	na	na	na	na
125 bbl Crude												
Time After Spill in Days	**1**	**3**	**10**	**30**		**1**	**3**	**10**	**30**			
Oil Remaining (%)	84	74	53	24		75	55	22	3			
Oil Dispersed (%)	5	13	31	56		14	32	62	80			
Oil Evaporated (%)	11	13	16	20		11	13	16	17			

Notes: Calculated with the SINTEF OWM Version 4.0 of Johansen et al. (2010) and assuming marine diesel and or Endicott crude of 23.1˚ API.
na = not applicable because no oil is estimated to remain.
[1] Summer (April 1–October 31), 12-knot wind speed, 9 degrees Celsius, 1-meter wave height. Average Marine Weather Area A (Brower et al., 1988).
[2] Winter Spill (November 1–March 31), 16-knot wind speed, 5 degrees Celsius, 1.8-meter wave. Average Marine Weather Area A (Brower et al., 1988).
Compiled by BOEM, Anchorage, Alaska Office (2020).

A-2.1.4 Small Spill Assumptions Summary

The analysis of small oil spill impacts assumes the following:

- Small spills are likely to occur during exploration, development, and production activities.
- Small spills are <1-, 5-, 13-, or 50-bbl for exploration and mostly 3-bbl, with two 125-bbl spills for development and production.
- Small spills from offshore refueling during G&G activities total <1 bbl annually with one individual spill of approximately 13 bbl over all G&G activities.
- Small spills during exploration and delineation drilling operations range from 5 up to 50 bbl.
- The oil types could be ultra-low sulphur diesel during exploration and delineation activities and crude, diesel, or condensate during development and production.
- The weathering for a 1-, 5-, 13-, or 50-bbl refined oil spill is as shown in Table A1, and the spill lasts <1–2 days on the water. A crude oil spill of 125 bbl lasts 30 days.
- All the oil reaches the vessel, facility, or the environment.
- There is no reduction in volume due to cleanup or containment (pollution prevention, containment, and cleanup are analyzed separately as mitigation and as disturbance).

- Small spills could occur any time of the year in open water or on landfast ice during exploration and delineation activities and at any time of the year during development and production.
- Chronic small spills are those occurring repeatedly for long periods in the same location (e.g., fueling or development facilities) or individual small spills of long duration (small undetected leaks).

A-2.2 Large Oil Spills

Large spills (≥1,000 bbl) are accidental and occur infrequently. The large spill analysis estimates their frequency and number and describes their source, the type of oil, and its weathering. The OSRA results refine the analysis by providing where a large spill may go and what it may contact, and the overall occurrence and contact from one or more large spills over the life of the proposed action.

BOEM estimates the mean number of large oil spills or gas releases is less than one. The chance of one or more large spills occurring is 19 percent and the chance of no large spills occurring is 81 percent over the E&D Scenario lifecycle considered for LS 258. BOEM assumes a large spill or gas release will occur and conducts a large oil spill and gas release analysis for development and production activities. This conservative analysis addresses whether such spills could cause serious environmental harm and informs the decision maker of potential impacts should an unlikely large spill or gas release occur. Assuming more large spills or gas releases than the estimated mean number helps to ensure that this EIS does not underestimate potential environmental effects.

A-2.2.1 Large Oil Spill Sizes, Source, and Oil Type

Because no large spills have occurred from Alaska OCS oil and gas activities, the large spill volume assumptions are based on the reported spills in the Gulf of Mexico and Pacific OCS (ABS, 2016). The Gulf of Mexico and Pacific OCS data show that a large spill most likely would occur from a pipeline or a platform. BOEM uses the median OCS spill volume as the likely large spill size because it is the most probable size for that spill-size category. The average is not a useful statistical measure because it can be skewed by outliers such as the Deepwater Horizon spill volume. The median size of a crude oil spill ≥1,000 bbl from a pipeline on the OCS from 1974–2015 was 3,750 bbl, and the average was 5,808 bbl (ABS, 2016, Table 24). The median spill size for a platform on the OCS from 1974–2017, was 3,283 bbl, and the average was 1,227,006 bbl (ABS, 2016, Table 13). BOEM calculated the median spill size for both platforms and pipelines from 1974–2015 to derive the median OCS spill volume of 3,750 bbl. For purposes of analysis, BOEM rounded to the nearest hundred, 3,800 bbl, and used this value as the likely large spill size.

The source is the place from which a large oil spill could originate. The sources are divided generically into production platforms or pipelines (ABS, 2016). The places where a large spill could occur are based on the E&D Scenario created for LS 258. Platform sources include spills from wells or diesel fuel tanks located on platforms. Large offshore pipeline spills include spills from the riser and from the offshore pipeline to the shore. Large onshore pipeline spills include spills from the shoreline to the refinery. The types of oil spilled from platforms are assumed to be crude oil, natural gas liquid condensate, or diesel oil. Large pipeline oil spills are assumed to be natural gas liquid condensate or crude oil.

A-2.2.2 Large Oil Spill Weathering

Estimates of the oil types that could spill, along with their weathering, inform analysis of the effect of a 3,800 bbl oil spill. Weathering includes how much oil evaporates, disperses, and remains after a certain time. BOEM uses the SINTEF OWM, Version 4.0 (Johansen et al., 2010) for diesel, condensate, and crude oil to derive weathering results for up to 30 days. The SINTEF OWM results are validated with data from three full-scale field trials of experimental oil spills (Brandvik et al., 2010; Daling and Strom, 1999).

A-2.2.2.1 Oil Weathering Scenario

The SINTEF OWM uses information about the general type of oil, laboratory weathering data, the volume of oil, the location of the spill, and the environmental parameters of temperature, wind speed, and ice concentration to simulate weathering. BOEM chose an ultra-low sulphur diesel oil and a condensate (Sliepner) with an American Petroleum Institute (API) gravity of 50°. The properties of crude oils are variable and when spilled result in different behavior. A medium crude oil, similar to crude oils representative of Trading Bay within the Cook Inlet Region, is used for this analysis. Crude oil samples recovered from wells within Cook Inlet state waters are characterized by a range of API gravity, which is a measure of how heavy or light the oil is compared to water. The crude oils in the Cook Inlet Region are estimated to range from API gravities of 20° to 40°. Given the existing information from crude oil samples recovered from Alaska state wells, BOEM chose the lower end of the range of API gravities which generally weather and degrade more slowly than higher API gravities. BOEM looked for data on crude oils with similar API gravity values that also had laboratory data on their weathering (evaporation, dispersion). Endicott 2001 crude oil has an API gravity of 23.1° and is representative for the oil weathering simulations because it is a medium crude oil that falls within the lower range of API gravity 20° to 40°.

Three general scenarios are simulated: one in which the oil spills into open water (April–November) and two in which the oil spills into open water or broken ice (December–March). BOEM assumes the spill starts at or quickly rises to the surface. Weathering of spills for open water and broken ice are modeled as if they are instantaneous spills. Although different amounts of oil could melt out of broken ice at different times, BOEM took the conservative approach and assumed all the oil was released at the same time.

A-2.2.2.2 Large Oil Spill Weathering and Persistence Results

Table A2 shows how much oil evaporates, disperses, and remains at the end of 1, 3, 10, and 30 days. In general, the low sulphur diesel fuel and condensate evaporate and disperse in a short period of time (1–10 days) during summer and remain longer in winter. The Endicott 2001 crude oil tends to evaporate and disperse more slowly.

The Endicott 2001 crude contains a relatively moderate amount of lower molecular-weight compounds that evaporate. Table A2 shows that approximately 17–20 percent of its original volume evaporates within 30 days at both summer and winter temperatures. Dispersion ranges from 1–56 percent (Table A2). However, at higher wind speeds (e.g., 15 meters per second wind speed), the oil spill will be almost removed from the sea surface within a day through evaporation and dispersion.

If an oil spill occurred and contacted shore, two important questions arise: (1) How much shoreline would be contaminated? and (2) How long would the contamination persist? Based on Equation 17 in Ford (1985), if a 3,800-bbl spill occurred and contacted land, about 26–35 kilometers (km) of coastline would be oiled (Table A2). The 35 km of coastline is approximately equal to the length of two land segments (LSs) in the OSRA model (see Section A-2.2.3). Table A.1-12 from Ji and Smith (2021) shows the environmental sensitivity index of Cook Inlet shorelines can range from low oil persistence to some shorelines where oil would persist for decades. In winter, ice along some portions of shorelines of the Cook Inlet could keep spills offshore away from the shoreline, and any oil that did reach shore may not penetrate into the frozen beach. For Cook Inlet shorelines, the relevance of persistence is much greater for spills during the summer than for spills during the winter.

Table A2: Weathering of a Large Oil Spill in the Cook Inlet OCS

3,800-Barrel Diesel Spill	Summer Spill[1]				Winter Spill[2]				Winter Spill (Broken Ice)[3]			
Time After Spill in Days	1	3	10	30	1	3	10	30	1	3	10	30
Oil Remaining (%)	40	1	na	na	10	0	na	na	65	19	0	na
Oil Dispersed (%)	36	66	na	na	69	77	na	na	11	40	54	na
Oil Evaporated (%)	23	33	na	na	21	23	na	na	14	41	45	na
3,800-Barrel Condensate Spill	**Summer Spill[1]**				**Winter Spill[2]**				**Winter Spill (Broken Ice)[3]**			
Time After Spill in Days	1	3	10	30	1	3	10	30	1	3	10	30
Oil Remaining (%)	0	na	na	na	0	na	na	na	0	na	na	na
Oil Dispersed (%)	29	na	na	na	29	na	na	na	29	na	na	na
Oil Evaporated (%)	71	na	na	na	71	na	na	na	71	na	na	na
3,800-Barrel Crude Oil Spill	**Summer Spill[1]**				**Winter Spill[2]**				**Winter Spill (Broken Ice)[3]**			
Time After Spill in Days	1	3	10	30	1	3	10	30	1	3	10	30
Oil Remaining (%)	86	75	55	24	79	57	23	3	89	84	76	61
Oil Dispersed (%)	3	12	31	56	10	30	61	80	1	3	8	19
Oil Evaporated (%)	11	13	16	20	11	13	16	17	10	13	16	20
Discontinuous Area (km^2)[3, 4]	12	50	241	998	12	50	240	992	12	50	240	992
Estimated Coastline Oiled (km)[5]	35				26				26			

Notes: Calculated with the SINTEF OWM Version 4.0 of Johansen et al. (2010) and assuming an ultra-low sulphur diesel, Sliepner Condensate, or Endicott Crude of 23.1° API.

1 Summer (April 1–October 31), 12-knot wind speed, 9 degrees Celsius, 1-meter wave height. Average Marine Weather Area A (Brower et al., 1988).

2 Winter Spill (November 1–March 31), 16-knot wind speed, 5 degrees Celsius, 1.8- meter wave heights and for Broken Ice 50% ice. Average Marine Weather Area A (Brower et al., 1988).

3 This is the discontinuous area of oiled surface.

4 Calculated from Equation 6 of Table 2 in Ford (1985) and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume. Note that ice dispersion occurs for about 30 days before meltout.

5 Calculated from Equation 17 of Table 4 in Ford (1985) and is the result of stepwise multiple regressions for length of historical coastline affected.

Compiled by BOEM, Anchorage, Alaska Office (2020).

A-2.2.3 OSRA Model

The OSRA uses spill rates, statistical methods, and oil spill trajectory modeling to derive information about large oil spill patterns. The OSRA report (Ji and Smith, 2021), Sections 2, 3.1–3.3, and Appendices A and B, are incorporated by reference and summarized here. The OSRA report is available to the public at: https://www.boem.gov/environment/environmental-assessment/oil-spill-risk-analysis-reports. The Lease Sale 258 OSRA estimates the chance of: (1) one or more large spills occurring; (2) a spill contacting resource areas assuming a spill has occurred at a specific location (conditional probabilities); and (3) one or more spills occurring and contacting resource areas (combined probabilities) (Ji and Smith, 2021).

A-2.2.3.1 Mean Number and Chance of One or More Large Spills Occurring

The large spill rate (1.11 spills per billion barrels (Bbbl); ABS, 2016) is multiplied by the production volume (0.1923 Bbbl) to estimate the mean number of spills (0.21). The chance of one or more large spills occurring is 19 percent and the chance of no large spills occurring is 81 percent over the E&D Scenario lifecycle considered for LS 258.

A-2.2.3.2 Conditional and Combined Probabilities

BOEM studied how and where large OCS spills move by using an oil spill trajectory model with the capability of assessing the chance of large spill contact to specific resource areas (Smith et al., 1982; Ji et al., 2011). This model analyzes the likely paths of slightly less than 800,000 simulated oil spill trajectories in relation to physical, biological, and sociocultural resource areas. The trajectory is constructed using the wind, sea ice, and current data from a coupled ice-ocean model.

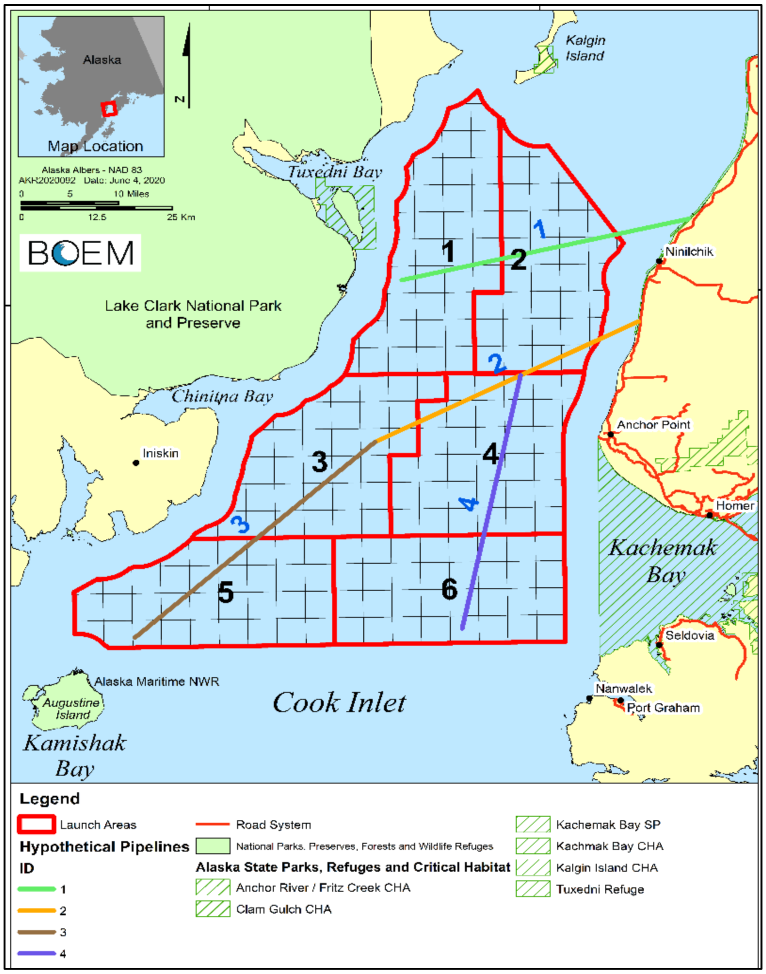


Figure A1: Areas Used in the Oil Spill Trajectory Analysis

The trajectory analysis in the OSRA used 6 hypothetical launch areas (LAs) and 4 pipelines (PLs) as locations where the hypothetical oil spill trajectory simulation starts. The LAs represent grouped locations of launch points that are spaced one per lease block throughout the Cook Inlet Proposed Action Area. The pipelines do not represent proposed pipelines or any real or planned pipeline locations. The LAs and PLs have no specific relation to the activities described in the LS 258 E&D Scenario. They are distributed throughout the Cook Inlet Area to evaluate differences in hypothetical oil spill trajectories from different locations. Figure A1 shows the 6 LA and 4 PL locations discussed in the OSRA report and how they were grouped geographically for this analysis.

Four types of onshore and offshore resource areas are used in the OSRA model: environmental resource areas (ERAs), land segments (LSs), grouped land segments (GLSs), and boundary segments (BSs). ERAs and BSs represent offshore areas while LSs and GLSs represent nearshore or onshore coastal areas of biological, social, or economic resource areas or resource habitats. BOEM analysts designated these resource areas by working with other federal and state agencies, academia, and various stakeholders who provided information, including local and traditional knowledge about these resources. Analysts also used information from BOEM's Environmental Studies Program research, literature reviews, and professional exchanges with other scientists to define these resource areas. The locations of resource areas, including islands and the coast within the model study area, were used by the OSRA model to tabulate the conditional and combined results for these areas (Ji and Smith, 2021).

The OSRA provides two datasets:

- Conditional Probabilities: Conditional probabilities are based on the assumption (condition) that a large oil spill has occurred at a given location. They reflect the hypothetical paths (trajectories) that oil would take based on modeled ocean surface currents, ice, and wind conditions in the study area. Tens of thousands of trajectories are simulated from each hypothetical spill point, and the percent chance of contact to resource areas within six different travel times (1, 3, 10, 30, and 110 days) are tabulated (Ji and Smith, 2021, Appendix A, Tables A.2-1–A.2-60). The conditional probabilities show statistically how, based on the surface current, sea ice, and wind patterns in the study area, spills originating in specific launch areas are more likely to contact particular resource areas than those originating in other locations.
- Combined Probabilities: Combined probabilities represent the estimated overall (combined) chance that one or more large spills will both occur and contact a specific resource area.

Combined probabilities incorporate conditional probabilities, spill rates, volume of oil, and the transportation scenario over the E&D lifecycle (Ji and Smith, 2021, Appendix A, Tables A.2-61–A.2-64). The combined probabilities are sensitive to oil resource volumes and transportation scenarios, which could vary in a frontier area.

A-2.3 Large Natural Gas Release

BOEM assumes one gas release from either an offshore or an onshore pipeline. Although unlikely, there exists some potential for a gas pipeline to rupture. The estimated rate of offshore gas pipeline ruptures in the Gulf of Mexico is 2.4×10^{-5} per pipeline mile per year (MMS, 2009). For 120 miles of offshore gas transmission pipelines, over a 32-year gas production life, the estimated number of incidents is 0.08 offshore gas pipeline ruptures. For onshore gas pipelines, the estimated spill rate for generic Department of Transportation (DOT) onshore gas transmission lines from 2002–2013 is 3.1×10^{-5} spill or release per pipeline mile per year (Lam and Zhou, 2016). Using DOT's rate, for the 1-mile onshore pipeline described in the E&D Scenario, 0.003 significant incidents are estimated over the 32-year gas production life of the E&D Scenario for LS 258. Under DOT regulation, significant incidents involve property damage of more than $50,000, injury, death, release of gas, or are otherwise considered significant by the operator.

If a major release of dry natural gas occurs, a sudden decrease in gas pressure would automatically initiate procedures to close the valves on both ends of the ruptured segment of pipeline. Closure of the valves would effectively isolate the rupture and limit the amount of natural gas released into the environment. Given the estimated daily flow rate, BOEM estimates that approximately 20 million cubic feet could be released over one day. Onshore, any gas releases from an elevated pipeline would disperse into the atmosphere. There is some small potential for ignition and subsequent explosion, but ignition sources are not readily available.

It is possible, though unlikely, that a loss of well control (LOWC) during natural gas production could cause a release of natural gas into the environment. A LOWC can result in a blowout, but blowouts do not always follow a LOWC incident. Also, the frequency of LOWCs can vary with the type of well drilled. The International Association of Oil and Gas Producers estimates the frequency of LOWC events at 3.6×10^{-4} gas blowouts per exploration well, and at 7.0×10^{-4} gas blowouts per development well drilled (IAOGP, 2010). The production well control blowout incident rate for production of gas is an order of magnitude lower, estimated at 5.7×10^{-5} blowouts per well year (IAOGP, 2010). The estimated mean number of gas releases is less than one (0.04). The chance of no gas blowouts occurring is 96 percent and the chance of a gas release occurring is 4 percent over the life of the Proposed Action or its alternatives.

In year 7 of the timeline described in the E&D Scenario associated with LS 258, infrastructure will have been installed, and sale of natural gas from the Proposed Lease Sale Area would presumably begin. When this occurs, it is assumed that one well control incident of a single well on the facility could occur, releasing 30 million cubic feet of natural gas for 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.

A-2.4 Large Oil Spills: Historical, Current, and Future

Over the past 55 years (1966–2020) approximately sixteen large onshore and offshore oil spills were documented in the Cook Inlet area, including Joint Base Elmendorf-Richardson (JBER), Port of Anchorage, Nikiski, Drift River, and marine waters near Kenai, Nikiski, Drift River, Fire Island, and Anchorage (ADEC, 2007, 2020; BOEM, 2016; Robertson et al. 2020; Whitney, 2002). These include crude, diesel, jet and aviation fuel and other types of petroleum spills from various onshore and offshore sources, including pipelines, tanks, platforms, tankers, and other vessels. No large marine spills have been documented since the 1989 M/V Lorna B diesel spill, and no large onshore spills since the 1997 aviation fuel spill on JBER.

BOEM estimated cumulative large oil spills resulting from current and future oil production for the onshore and offshore region of Cook Inlet. BOEM estimates 0–2 large spills from onshore and offshore state lands and from potential production resulting from development of leases sold in LS 244 and a future OCS lease sale beyond LS 258 (Table A3). BOEM assumes Cook Inlet LS 258 would contribute 0–1 additional large spill. For the number of large spills, the incremental contribution could range from 0–33%.

Table A3: Potential Large Spills from Current and Future Production

Location	Reserves/ Resources (Bbbl)	Spill Rate (spills/Bbbl)	Size Category (bbl)	Size (bbl) Pipeline/Facility	Mean Number of Spills	Number of Large Spills
State Onshore and Offshore	0.599[1]	1.11[4]	≥1,000	3,800	0.67	0–1
Cook Inlet OCS Sale 244	0.215[2]	1.11	≥1,000	3,800	0.24	0–1
Cook Inlet OCS (Future)	0.260[3]	1.11	≥1,000	3,800	0.29	
Total					1.2	0-2

Notes: [1] State Onshore and Offshore (USGS 2011).
[2] BOEM (2016).
[3] Future OCS Resources (Bradway 2020, pers. comm.).
[4] OCS spill rate (ABS Consulting, Inc., 2016).
Compiled by BOEM, Anchorage, Alaska Office (2020).

A-3 Oil Spills and Gas Release Analysis

The following sections analyze the impacts of small spills, a large spill or gas release, spill drills, and response activities on each physical, biological, sociocultural, and economic resource. The resource sections begin with an overview of general oil and gas exposure effects. Each of these hypothetical spills or releases has varying potential to result from OCS oil and gas exploration, development, and production. A set of assumptions, which collectively form the Spill Scenario (EIS Section 3.1), provides EIS analysts with a consistent and logical estimate of the size of spills, where a spill may go, how long it may take to contact an area of concern, and how oil will weather to inform the impact analyses through a common assessment framework.

For the large spill analysis, BOEM focuses the OSRA conditional information into one timeframe in each of two seasons to identify the season in which a large spill begins. The season determines wind and wave conditions and how much ice is present, contributing to the behavior of spilled oil and how long it persists. A 3,800-bbl crude oil spill persists in summer (open water) and in winter (sea ice) for up to 30 days. The season also informs the environmental analysis, including biota presence and abundance, and subsistence harvest patterns. The OSRA combined information is focused into an annual timeframe.

The OSRA model includes resource areas with defined geographic locations and temporal timeframes: coastal and estuarine habitat; invertebrates and fish; birds; marine mammals; terrestrial mammals; recreation, tourism, and sport fishing; subsistence activities and harvest patterns; and archaeological resources. The commercial fishing analysis considers fish resource areas. Non-spatial resources—air quality, water quality, sociocultural systems, community health, economy, and environmental justice—are not examined in the OSRA model, but the analyses consider the spatial extent where a large oil spill could travel and its timeframe.

The tables and figures in the following sections show resource areas with the highest chance of contact (≥1%) from any spill area within 30 days from a large spill during summer or winter. 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 invertebrates and fish, marine mammals, or terrestrial mammals, based on the spill assumptions in Appendix A, Section A-2. The conditional analysis for each resource tiers to BOEM (2016) Chapter 4 and each resource subsection titled Oil Spill Risk Analysis therein is incorporated by reference and summarized in each resource section below. The conditional and combined probability results are reported in Ji and Smith (2021).

A-3.1 Air Quality

The airborne constituents associated with a release of refined or crude oil would release potentially harmful emissions into the atmosphere, particularly those pollutants regulated under the Clean Air Act: nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter (PM_{10} and $PM_{2.5}$). An oil spill or gas release would also include volatile organic compound (VOC) emissions, which are a precursor to ozone (O_3). Additional airborne constituents associated with oil or natural gas releases, which have environmentally harmful consequences, are methane and black carbon. Mechanisms that lead to impacts on air quality include:

- Aerosol formation by wind and wave action can transfer oil components into the atmosphere (Aeppli et al., 2013; Arey et al., 2007; de Gouw et al., 2011).
- Evaporation of volatile components degrades air quality in the immediate vicinity of the spilled oil (Hanna and Drivas, 1993; Harrill et al., 2014; Middlebrook et al., 2012).
- A fire or in-situ burning response operations increase emissions of nitrogen oxides (NO_x), SO_2, and CO, but decrease emissions of VOCs as compared to evaporation (Fingas, 2017).
- Response operations increase aircraft, surface vehicle, and ship emissions (Middlebrook et al., 2012).

Additional discussion of the general impacts of oil and gas spills on air quality is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.1)

A-3.1.1 Small Oil Spills (<1,000 bbl)

The impacts of small spills at a given location would depend on the time of year; size, location, and duration of the spill; and meteorological conditions such as wind speed and direction. Evaporation of small accidental oil spills would cause brief localized increases in VOCs. However, the volume of VOC emissions resulting from such small spills is not expected to be sufficient to create conditions favorable for the formation of ozone.

The volatile components of diesel fuel would evaporate within the first 6–24 hours for a spill <1 bbl, 2 days for a spill of 50 bbl, and 30 days for a crude spill of 125 bbl (Table A1). This evaporation would potentially cause localized air quality degradation near the spill. Small crude oil spills would take longer to evaporate than refined product spills and result in air quality impacts over an extended timeframe in a localized area.

A-3.1.2 Large Oil Spill (≥1,000 bbl)/Gas Release

A natural gas release could adversely impact air quality, depending on the size and duration of the release and whether it is ignited. While methane, the principle component of natural gas, is a potent greenhouse gas, it is not a regulated criteria pollutant. But when methane is combusted, it generates emissions of NO_2, CO, SO_2, and PM. A condensate or diesel spill would evaporate and disperse within 1–13 days, and 17–20 percent of a crude oil spill would evaporate within 30 days (Table A2). An estimated 26 to 35 km of shoreline, and an area of 992 to 998 km^2 offshore, could be impacted (Table A2). A large, 3,800 bbl spill would increase VOC emissions over a larger area and for a longer period than a small spill. The emissions would continue until all the VOCs evaporated or the oil is removed from the water surface. The crude oil evaporates over 30 days (Table A2).

Offshore, assuming no oil would freeze into the sea ice, the distance, combined with the wind conditions over Cook Inlet, would likely disperse the VOCs. The emissions may be picked up by upper-level winds and transported away.

Emissions of VOCs from oil released near the shoreline could interact with existing NO_x emissions and lead to ozone formation near communities. The ability of VOCs to participate in the formation of ozone would depend on whether the large oil spill occurred in the summer or the winter. Along with a favorable mixing ratio of VOCs to NO_x, the formation of ozone requires sunlight. The intensity of sunshine over southcentral Alaska is moderate in the summer, and the opportunity for ozone formation exists. Ozone formation is unlikely to occur over Alaska in the winter when there is limited sunlight. A large crude oil spill would persist longer in the environment and is more widespread than a small spill.

A-3.1.3 Spill Drills and Response Activities

Emissions associated with spill drills, including GIUEs, would be caused by the combustion of diesel fuels from mobile sources (trucks and vessels). As a result, the dominant air pollutants produced during these exercises are those common to engine combustion: NO_x, $PM_{2.5}$, and PM_{10}. The amounts of emissions released as a part of spill drills are expected to be similar to the everyday emissions from ships regularly operating in that area. The resulting air quality impact would be localized to the immediate spill drill area and would last only for the duration of the drill. Within minutes to hours of the completion of the exercise, the air quality would recover and return to pre-exercise levels. It is likely the exercise would result in little to no air quality impacts.

Three response activities that could affect air quality are use of dispersants, in-situ burning, and mechanical recovery, all of which would include mobile sources of emissions from response vehicles. U.S. Environmental Protection Agency (EPA) suggests that using dispersants for oil spill cleanup would cause little or no impact on air quality (EPA, 2015). Most mobile emissions, including those of trucks or vessels participating in large spill response operations, have a limited 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. Pollutant concentrations decrease with increasing distance from the source. In-situ burning would result in short-term and widespread increases in emissions of NO_x, $PM_{2.5}$, and PM_{10}. Impacts of burning spilled oil are analogous to the emissions from engine combustion (described in EIS Section 4.3.2). In-situ burning also produces soot, or black carbon. This soot may be deposited on ice or snow and cause increased melting because the dark particles absorb heat (the albedo effect). Thus, the consequences of methods used to remove oil may actually outweigh the air quality impacts of the oil itself.

A-3.1.4 Conclusion

Impacts to air quality would be minor for small spills and minor to moderate for a large oil spill. A large gas release would have a minor to moderate impact to air quality, depending on the size of the release, its duration, and whether ignition occurs. Oil spill drills would have negligible impacts to air quality. Spill response and cleanup would have minor to moderate impacts to air quality.

A-3.2 Water Quality

The impacts of oil spills and gas releases on water quality are dependent on the type of oil; its chemical characteristics; how and where the oil is released into the water; the ambient temperature; sediment type and quality; and other environmental factors of the receiving environment at the time of the release. The fate and behavior of spilled oil, including weathering processes, also influence its impacts on water quality (Section A-2.1.2 and A-2.2.2, and BOEM, 2020, Section 4.4). Physical, chemical, and biological processes in the aquatic environment, coupled with the specific composition of the spilled oil, impact water quality.

- Impairment of water quality is regulated through the Clean Water Act administered by the EPA, and the State of Alaska's Water Quality Standards, 18 Alaska Administrative Code (AAC) 70 (ADEC, 2018).
- Water quality impacts are influenced by the spills' initial release to either the surface water, subsurface, or seafloor, affecting the distribution, composition, and persistence of oil constituents (Boehm, Neff, and Page, 2013; Camilli et al., 2010).
- Toxicity and persistence of petroleum hydrocarbons varies with time, specific hydrocarbons, and location within the water column (Allen et al., 2012; Capuzzo, 1987; Neff, 2002; Neff and Durrell, 2011; Speight, 2007; Wiens, 2013).
- Fate, toxicity, bioaccumulation, and bioavailability of petroleum settling to the seafloor or shoreline varies due to sediment type and quality (Allen et al., , 2012; Capuzzo, 1987; Neff, 1979, 2002; Neff and Durrell, 2011; Sharma and Schiewer, 2016; Wade et al., 2011; Wang et al., 2003).
- Natural gas displaces oxygen in the water column, and when released at depth, has been linked to an increase of methanotrophic activity (Joye et al., 2011; Valentine et al., 2010; Wimalaratne et al., 2015; Yvon-Lewis et al., 2011).

Additional discussion of the general impacts of oil and gas on water quality is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.2).

A-3.2.1 Small Oil Spills (<1,000 bbl)

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 of hydrocarbons and weather primarily through evaporation. The rate of evaporation accelerates with rising temperature and increased wind speed. Modeled weathering calculations provided in Table A1 show that diesel spills from <1 bbl to 50 bbl evaporate and disperse within 6–24 hours in open water, respectively. Immediate, yet temporary exceedances of water quality standards for total aromatic hydrocarbons (TAHs) would result with water quality expected to return to ambient conditions within 2 days.

By contrast, small crude oil spills persist longer in the environment. These spills have the potential for a greater extent of horizontal and vertical contamination of the surface waters and water column. Hydrocarbons can volatilize into the air, dissolve into the water column or water surface, oxidize via ultraviolet radiation or microbial activity, or emulsify and float or sink to the subsurface (NRC, 2003a). A crude oil spill of 125 bbl would impact water quality longer in summer (>30 days) than in winter (~30 days) (see Table A1) when dispersion and evaporation rates are less due to lower wind speeds and wave heights. A small crude spill, or repetitive small oil spills, in open water would introduce hydrocarbon contaminants of various weights and toxicities into the marine environment, causing a temporary decrease in water quality. During ice season, small crude oil and condensate spills could affect the localized surface quality of ice, as well as surface water quality if the spill occurred in broken ice. TAH concentrations would be more likely to freeze into the ice than to dissolve or disperse. After the onset of melting, oil spilled under ice returns to the surface in an un-weathered state.

A-3.2.2 Large Oil Spill (≥1,000 bbl)/Gas Release

A large, 3,800 bbl oil spill would impact water quality by introducing hydrocarbons onto the sea surface, into the water column, and in seafloor sediments. Crude oil on the sea surface spreads initially under the influence of gravity and surface tension to form slicks with an average thickness of less than 1 millimeter (mm), and often as low as 0.1 millimeters (mm) (Lee et al., 2013). Subsequently, the slick-thickness will either decrease or increase depending on characteristics of the oil, the influence of surface factors (wind, waves, currents, temperature, salinity, etc.), and spill response actions (Beyer et al., 2016). 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 TAHs 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.

Oil and oil residues can interact with settling particles in the water column, providing a natural removal process (Tarr et al., 2016). Polycyclic aromatic hydrocarbons (PAHs), a component of total aqueous hydrocarbons (TAqH), from any discharge quickly attach onto particulate matter, and large amounts from the water are then deposited in bottom sediments where they are readily accumulated by aquatic biota (Neff, 1986). A small portion of the oil from a surface spill would be deposited in the sediments in the immediate vicinity of the spill or along the pathway of the slick. The observed range in deposition of oil in bottom sediments following offshore spills is 0.1–8 percent of the slick mass (Jarvela et al., 1984). Generally, the higher percentage of deposition occurs in spills nearshore where surf, tidal cycles, and other inshore processes can mix oil into the bottom. Farther offshore, where suspended sediment loads are generally lower, only about 0.1 percent of the crude would be incorporated into sediments within the first 10 days of a spill (Manen and Pelto, 1984).

An oil spill during the winter could occur in broken ice conditions. The oil would freeze into, move with, and melt out of the ice the following spring. Oil-contaminated ice could drift for tens of km prior to melting out. Due to the reduced wave-induced emulsification process, oil released from the ice would have the characteristics of fresh oil (Barber et al., 2014). Decomposition and weathering processes for oil are much slower in cold waters than in temperate regions due to lower evaporation rates. Refined oils, condensates, and diesel products, would weather much more quickly than crude oil, as described above, and would be generally dispersed within 2 days. After 30 days, approximately 3–24 percent of crude oil is estimated to remain in open water and 61 percent in ice (Table A2).

Severe, potentially widespread and long-lasting impacts to water quality and exceedances of Alaska's water quality standards for both TAH and TAqH would occur immediately after a large oil spill. The acutely toxic and highly volatile TAHs are likely to have a pronounced, short-term fluctuation and would likely rapidly dissipate from the spilled oil within a day. However, elevated levels of the less volatile and soluble PAH compounds would be expected in the water column for up to a month. These compounds are unlikely to persist in the water column for an extended period, but rather, are more likely to accumulate in sediments where they can remain for decades under some conditions (ADEC, 2015).

Little to no water quality impacts are expected during the short, 1-day duration of the gas release, but water quality could temporarily be impacted during the release. When natural gas (primarily methane) is released into the water, it rises through the water column as a function of pressure and temperature, temporarily displacing oxygen. When released at depth, the quality of the water would be altered temporarily and in deeper, colder waters some of the natural gas enters the water as a water-soluble fraction. Upon reaching the surface, the gaseous methane would react with air forming water and carbon dioxide (CO_2), which would then disperse into the atmosphere. The higher concentration of CO_2 near the surface would affect chemical and biological processes and reactions at the water-air interface such as egg and larvae respiration (GESAMP, 1995).

A-3.2.3 Spill Drills and Response Activities

There is potential for small refined oil spills during spill drills, including GIUEs; however, these events are infrequent and of short duration (<8 hours) and would result in little to no impact on water quality. Additional impacts on water quality would occur from spill response and cleanup activities for large oil spills, including impacts from vessels, in-situ burning of oil, dispersant use, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring (BOEM, 2019). Permitted and incidental discharges from spill response vessels would temporarily impact localized water quality by increasing levels of low molecular weight hydrocarbons (TAH). However, the volatility of TAHs results in very short-term exposure durations, particularly if the source is intermittent as from passing motorized watercraft. Exposure to elevated TAH concentrations is likely in instances when watercraft are numerous and in a particular area for sustained periods. In-situ burning has the potential to impact water quality by increasing surface water temperatures while the oil slick is burning. Temperatures of crude oil burns on water vary from 900°C to 1,200°C; however, the temperature at the oil slick/water interface is never more than the boiling point of water and is usually around ambient temperature (Mullin and Champ, 2003). Any increase of surface water temperature would be temporary and short-term, if at all, returning to ambient temperature when the burning stops. Additionally, in-situ burning produces viscous oil and soot residues that initially float but may sink as they cool. In-situ residues (i.e., "tar paddies") exhibit little water solubility and have no detectable acutely toxic compounds (Mullin and Champ, 2003). Toxicity of dispersants to aquatic life are species- and chemical-specific, but dispersant persistence and toxicity levels have been documented in the water column and marine sediments (Lewis and Pryor, 2013; White et al., 2014). Shoreline spill response activities disturbing contaminated shoreline sediments can reintroduce stranded oil from back into the water column and drive contaminates farther into shoreline sediments. Weathered, and more viscous higher molecular weight hydrocarbons would most likely be present, and although lower in toxicity, these PAHs can persist for decades in sediment.

A-3.2.4 Conclusion

Oil spills or a gas release could affect marine surface, coastal, and tidal riverine waters with potentially toxic levels of hydrocarbons until the process of dispersion, dilution, degradation, and weathering reduce oil and oil residue concentrations. A small spill would cause minor impacts and would not result in any long-lasting change to water quality nor its function in the ecosystem, whereas a large spill would cause moderate impacts to water quality based on the volume of oil spilled. A large gas release or spill drills would cause negligible impacts to water quality, and spill response and cleanup actions would cause negligible to minor impacts.

A-3.3 Coastal and Estuarine Habitat

The magnitude and severity of oil spill impacts to coastal and estuarine habitats are contingent upon the type and amount of spilled oil, substrate and shoreline type, amount of vegetation coverage, plants' seasonality at the time of the release (spring vs. fall), depth of penetration of the oil into the sediments, and type and effectiveness of any cleanup or remedial actions (NRC, 2003a). Oil spill impacts to coastal and estuarine habitat include:

- Impacts of persistent crude oil to wetlands and shoreline with permeable, fine-grained sediments include habitat smothering and oiling of beaches (Atlas and Bragg, 2013; Harper and Morris 2014; Mendelssohn et al., 2012; Michel et al., 2017; Michel and Rutherford, 2013).
- Crude oil exhibits less toxicity to plants than refined products such as diesel, however repetitive oiling to the root zone can cause plant death (Achuba, 2006; Hester and Mendelssohn, 2000; Jorgenson, 1997; Lin and Mendelssohn, 1996, 2012; McKendrick, 2000; Walker et al., 1978).
- Rehabilitation and restoration of vegetation from oil and diesel spills can be long-term with oil byproducts remaining in the soil for many years (Conn et al., 2001; Jorgenson et al., 2003; McKendrick and Mitchell, 1978).

Additional discussion of the general impacts of oil and gas on wetlands and vegetation is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.3), and that analysis is incorporated by reference.

A-3.3.1 Small Oil Spills (<1,000 bbl)

Small offshore spills of light refined oil products can directly damage or kill vegetation by penetrating and destroying plant tissues (Behr-Andres et al., 2001). Diesel or refined product spills (<1–50 bbl) are estimated to evaporate in 24 hours in summer, and 6 hours in winter (Table A1). However, despite their evaporation rates, direct contact by diesel or refined product spills of any size could impact and cause lethality to emergent wetland vegetation. In contrast, crude oil shows little direct toxic effects to most plants unless the plant is heavily oiled, is a sensitive species, or oil has penetrated the soil/sediment and the roots are continuously exposed to oil. For a 125-bbl crude oil spill in summer, 24 percent remains after 30 days; in winter, 3 percent remains after 30 days (Table A1). Because of the rapid dispersion and evaporation during summer, it is very unlikely that impacts or injury to coastal and estuarine habitats, including wetlands and vegetation, would result from an offshore summer crude oil spill. Moreover, the majority of offshore small spills are contained on a vessel or platform, and spills making contact with water are expected to be contained by appropriate spill response activities. During winter, ice or snow could act as a barrier preventing oil and refined product from contacting estuaries, saltwater wetlands, and shorelines.

Most onshore small diesel spills are expected to occur during refueling on established roads or pads and are unlikely to contact wetland vegetation. Should a diesel spill occur during summer, direct contact with vegetation would result in immediate injury and potential lethality to vegetation. A 125-bbl crude oil spill has the potential to impact terrestrial vegetation and wetlands, particularly if the spill occurred during the summer. The spatial extent of impacted terrestrial wetland habitat depends upon wind and weather conditions at the time of the release, and the type of pipeline failure (pinpoint vs. rupture). Under windy conditions, a pressurized aerial mist could spray crude oil and impact many acres, but long-term injury resulting from heavy oiling or root penetration would not be expected. Winter spills with adequate snow cover are more readily cleaned up because contaminants can be removed as frozen material and soil penetration of oil contaminants is minimal (McKendrick, 2000).

A-3.3.2 Large Oil Spill (≥1,000 bbl)/Gas Release

An offshore large crude or refined oil spill during summer or broken-ice conditions could impact coastal and estuarine habitats, including shorelines, supratidal, intertidal, and subtidal communities. A large spill of crude oil would persist longer in the environment and result in greater, long-term impacts than spills of refined products which weather more rapidly. A 3,800-bbl crude oil spill in Cook Inlet is estimated to oil 35 km (21 miles (mi)) of coastline in summer and 26 km (16 mi) in winter (Table A2).

Alaska's coastal and estuarine habitats are rich in biological resources that are sensitive to spilled oil. During summer, these habitats are ideal environments for migratory birds, fish, invertebrates, and foraging mammals. Coastal and estuarine habitats of Cook Inlet are varied and have different vulnerabilities to oil exposure; persistence of oil also varies between supratidal, intertidal and subtidal habitats once exposed. Porosity of the shoreline substrate is an important determinant of the extent to which a 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 and would be expected to retain spilled oil longer with longer-lasting impacts on biota (Culbertson et al., 2008). In contrast, shorelines in middle Cook Inlet are characterized by exposed tidal flats that are less sensitive to oiling (NOAA, 2002). Exposed rocky cliffs, headlands, and sheltered rocky coasts are characteristic shoreline types in lower Cook Inlet.

BOEM analyzed the vulnerability of Cook Inlet's coastal and estuarine habitats to an oil spill (BOEM, 2016-069, Section 4.3.9.5, pp 4-179 through 4-184) and that analysis is incorporated by reference. BOEM's full analysis includes a thorough explanation of the vulnerability of Cook Inlet's diverse shorelines, supratidal, intertidal, and subtidal communities to oil impacts, and the relevant assumptions for these explanations. Specifically, this analysis includes a description of the impacts of the Exxon Valdez Oil Spill (EVOS) to different shore types in Prince William Sound, on the Kenai and Alaska Peninsulas, and in the Kodiak Archipelago. The environmental sensitivity index (ESI) used both in the EVOS and this OSRA, ranks shoreline types on a scale from 1 to 10 (10 being the most sensitive) based on predicted sensitivity to disturbance from oil spills and cleanup operations. Although the EVOS was a VLOS event spilling a much greater volume of crude oil than a large oil spill, the vulnerability and persistence of oil pollution to the various shore types and coastal habitats of Prince William Sound impacted by the EVOS, is pertinent to the shore types and coastal habitats found in Cook Inlet.

The concentration of low-molecular-weight alkanes and aromatics in crude oil is a primary determinant of toxicity. Heavy and medium crude oils exhibit a low level of direct toxicity upon contact to plants, whereas light crudes and refined products, such as diesel, can cause necrosis and plant mortality on contact (Mendelssohn et al., 2012). Oil and oil residues stranded in emergent wetland vegetation would be expected to persist for decades due to lower rates of dispersion and degradation. Destruction of emergent vegetation could occur if oil penetrates the root system (Mendelssohn et al., 2012). Oil contamination could persist for many years as oil in the sediments could be released back into the environment as a result of erosion or exposure of oiled sediments and soils. Oil persistence in marsh sediments could impact microbial communities in the soil and sediment resulting in long-term wetland effects and potential slow recovery (Delaune et al., 1990; Teal and Howarth, 1984; Teal et al., 1992).

An offshore gas release is expected to travel through the water column and dissipate quickly; coastal and estuarine habitats near the gas release could be exposed to lower oxygenated waters, however little to no impacts to coastal and estuarine habitats would be expected.

A large onshore spill of crude, condensate, or diesel would impact terrestrial vegetation and wetlands. The areal extent of the spill would depend on the season, wetland and soil type, wind conditions, and type of pipeline spill (rupture versus pinhole) at the time of the release. Should a pressurize pipeline fail and oil spray into the air, under windy conditions oil may be carried downwind and deposited over a widespread area (NRC, 2003b). During summer, a large spill could saturate wetland soils, penetrate the active layer of the soil and by coating plants' roots and rhizomes cause severe and detrimental impacts to wetland vegetation. In the case of a refined petroleum spill where direct toxicity is substantial, mosses and aboveground vascular plants would be killed on contact. During winter, snow and ice buffers vegetation from oil impacts and limits the extent of oil spreading. Cold temperatures would further retard oil from spreading, reducing the areal extent of impact.

An onshore gas release could result in thermal impacts to terrestrial vegetation and wetlands should ignition occur. The areal extent of thermal impacts and burning of vegetation would depend on the season, weather conditions, moisture content of vegetation, and suppression efforts. Little to no impacts to vegetation and wetlands is expected under most situations, unless an explosion, ignition, or fire ensues resulting in severe impacts.

A-3.3.2.1 Oil Spill Risk Analysis

The OSRA acronyms are LS Land Segment, LA Launch Area; and PL Pipeline. BOEM identified 112 LSs and their environmental sensitivity index (ESI) for this analysis (Ji and Smith, 2021; Tables A.1-11 and A.1-12; Figures B-3a–3d). The ESI is a numerical index ranking the vulnerability of a coastline's natural characteristics to impacts from oil spills. The higher the ESI number, the more vulnerable the coastline is to oil spills.

Conditional Probabilities. Table A4 and Figure A2 display 39 LSs with a ≥1 percent chance of contact in summer or winter. Although every LS in Table A4 has a chance of contact, most of these contacts range from 1–5 percent. For this analysis, only the 11 LSs with a ≥6 percent chance of contact during summer or winter are discussed further (Table A4). Overall, the pattern of contact from north to south, on western and eastern shorelines is similar between summer and winter seasons. The western LSs have a greater chance of contact than the eastern LSs, and the more northern LSs have a greater chance of contact than the southern LSs. As identified by the ESI (Ji and Smith, 2021, Table A.1-12), most of the shorelines within the LSs, are characteristically mixed sand/gravel beaches, exposed and sheltered tidal flats, wave-cut bedrock, and salt/brackish water marshes.

Summer. For a summer spill, 8 western LSs from Redoubt Point (36) to Amakdedulia Cove, Bruin Bay, Chenik Head (28), and Augustine Island (29) have a chance of contact. The highest chance of contact is the most northern of the contacted western LSs at Redoubt Point (36) from a LA1 spill (Ji and Smith, 2021, Table A.2-29). Chinitna Bay (33) has the greatest chance of contact from all LAs and PLs, and the chance of contact decreases steadily to Amakdedulia Cove, Bruin Bay, Chenik Head (28) in the south. Three eastern LSs have a similar chance of contact from a spill in LA6 or LA5: Cape Starichkof, Happy Valley (56), Barbara Point, Seldovia Bay (61) and Nanwalek, Port Graham (62) (Ji and Smith, 2021, Table A.2-29).

Winter. A winter spill has a chance of contacting the same western LSs as identified above for summer, with the addition of Iliamna Point (34). Chinitna Bay (33), as for a summer spill, has the greatest chance of contact from all LAs and PLs, and the chance of contact decreases steadily to the south at Amakdedulia Cove, Bruin Bay, Chenik Head (28). Only two eastern LSs, Cape Starichkof, Happy Valley (56) and Port Graham (62), have a chance of contact from LA6 and PL2, respectively (Ji and Smith, 2021, Table A.2-49).

Table A4: Highest Percent Chance of a Large Spill Contacting Coastal and Estuarine Resources (Assuming a Large Spill Occurs)[1]

OSRA Feature Type	Highest Chance of Contact	Summer: 30 days	Winter: 30 days
LS	≥0.5–<6	18, 19, 20, 21, 22, 23, 24, 25, 26, 34, 37, 38, 40, 54, 55, 57, 58, 60, 63, 79, 80, 81, 82, 83, 84, 85, 86, 87	21, 22, 23, 24, 25, 26, 27, 37, 38, 39, 40, 54, 55, 57, 58, 60, 61, 63, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88
LS	≥6–<25	28, 29, 30, 31, 32, 33, 35, 36, 56, 61, 62	28, 29, 30, 31, 32, 33, 34, 35, 36, 56, 62
Names of LSs Contacted: 18 Alinchak Bay, Cape Kekurnoi, Bear Bay; 19 Cape Kubugakli, Kashvik Bay, Katmai Bay; 20 Amalik, Dakavak and Kinak Bays, Cape Iiktugitak, Takli Island; 21 Kaflia Bay, Kukak Bay, Kuliak Bay, Missak Bay; 22 Devils Cove, Hallo Bay; 23 Cape Chiniak, Swikshak Bay; 24 Fourpeaked Glacier; 25 Cape Douglas, Sukoi Bay; 26 Douglas River; 27 Akumwarvik Bay, McNeil Cove, Nordyke Island; 28 Amakdedulia Cove, Bruin Bay, Chenik Head; 29 Augustine Island; 30 Rocky Cove, Tignagvik Point; 31 Iliamna Bay, Iniskin Bay, Ursus Cove; 32 Chinitna Point, Dry Bay; 33 Chinitna Bay; 34 Iliamna Point; 35 Chisik Island, Tuxedni Bay; 36 Redoubt Point; 37 Drift River, Drift River Terminal; 38 Kalgin Island; 39 Seal River, Big River; 40 Kustatan River,West Foreland; 54 Clam Gulch, Kasilof; 55 Deep Creek, Ninilchik, Ninilchik River; 56 Cape Starichkof, Happy Valley; 57 Anchor Point, Anchor River; 58 Homer, Homer Spit; 59 Fritz Creek, Halibut Cove; 60 China Poot Bay, Gull Island; 61 Barabara Point, Seldovia Bay; 62 Nanwalek, Port Graham; 63 Elizabeth Island, Port Chatham, Koyuktolik Bay; 79 Barren Islands, Ushagat Island; 80 Amatuli Cove, East & West Amatuli Island; 81 Shuyak Island; 82 Bluefox Bay, Shuyak Island, Shuyak Strait; 83 Foul Bay, Paramanof Bay; 84 Malina Bay, Raspberry Island, Raspberry Strait; 85 Kupreanof Strait, Viekoda Bay; 86 Uganik Bay, Uganik Strait, Cape Ugat; 87 Cape Kuliuk, Spiridon Bay, Uyak Bay; 88 Karluk Lagoon, Northeast Harbor, Karluk.			

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all LSs with <0.5 percent chance of contact are not shown.
Source: Ji and Smith (2021).

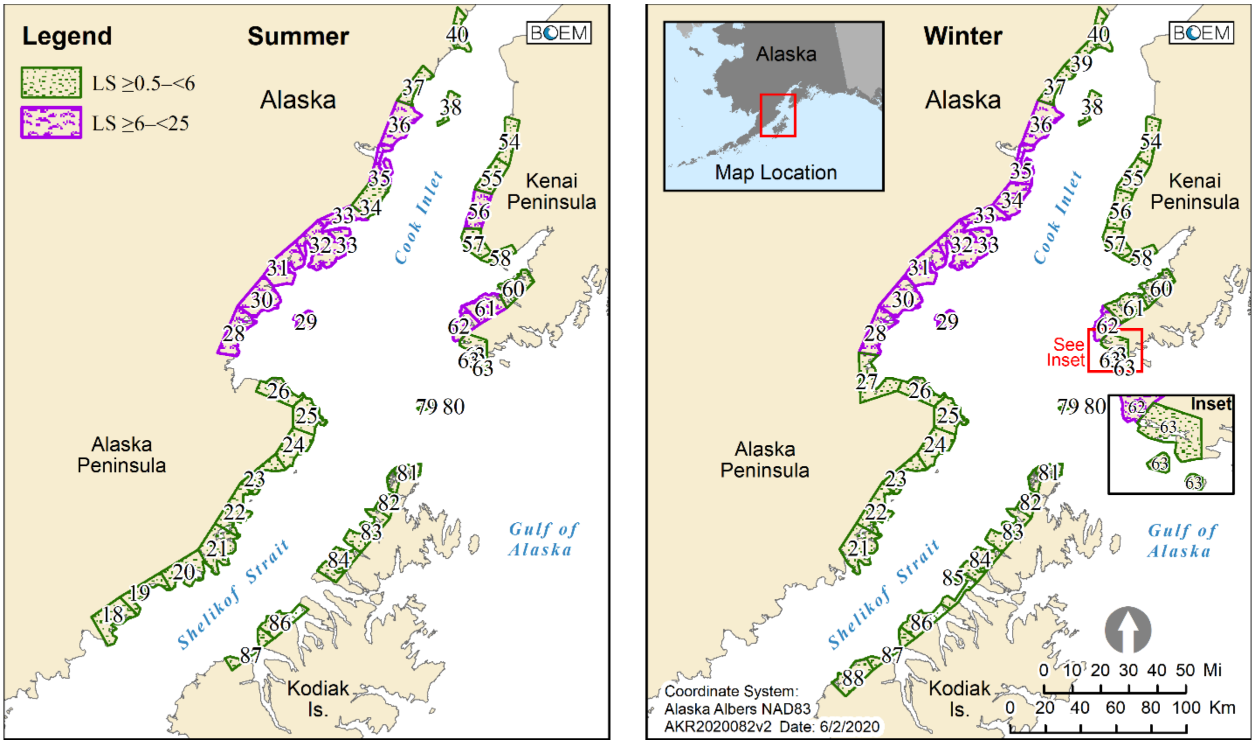


Figure A2: Location and ID number of Land Segments (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

Combined Probabilities. The OSRA model estimates a <1–3 percent chance of one or more large spills occurring and contacting LSs 25, 28–36, 56, and 62 within 3 to 30 days (Ji and Smith, 2021, Table A.2-62). The greatest chances of occurrence and contact within 30 days are 3 percent for Chinitna Bay (33) and 2 percent for Chisik Island, Tuxedni Bay (35), both located on the western coastline of Cook Inlet; LSs 25, 28–32, 34, 36, 56 and 62 all have a 1 percent chance of occurrence and contact.

A-3.3.3 Spill Drills and Response Activities

Spill drills, including GIUEs, would be infrequent and localized and are expected to have little to no impacts to coastal and estuarine habitats.

Skimming, booming, in-situ burning, and other spill response and cleanup operations can be effective means of preventing offshore oil spills from reaching coastal and estuarine habitats, and shorelines (BOEM, 2019). Spill cleanup operations might impact coastal beaches if the removal of contaminated substrates affects beach stability and results in accelerated shoreline erosion. Vehicular and foot traffic during cleanup could mix surface oil into the subsurface, where it would likely persist for a longer time. Manual cleanup, rather than the use of heavy equipment, would minimize the amount of substrate removed due to effects of motorized vehicles on fragile soils.

Spill response for onshore contaminated wetland vegetation usually involves low pressure flushing to mobilize the oil and remove it, along with removal of the most highly contaminated soils. Scraping the surface is designed to leave plant parts (roots, rhizomes) intact so that sprouting will occur the following spring (Cater et al., 1999). Faster rehabilitation of vegetation and wetlands occurs if spill cleanup is aided by use of fertilizers and other bioremediation applications (McKendrick, 2000a

A-3.3.4 Conclusion

The environmental conditions at the time and location of an oil spill, the habitat type and substrate of the shoreline, oil type, and size of the spill are critical factors that influence the extent of impacts to coastal and estuarine habitats. Oil contamination on shorelines, supratidal, intertidal and subtidal habitats consisting of tidal flats, sand/gravel beaches, rocky shores, and saltwater marshes would have long-term and widespread impacts for many years. Impacts would be negligible to minor for small spills, and moderate to major for a large oil spill, contingent upon these defining factors. A negligible to minor impact would not result in any long-lasting detrimental effects on the overall ecological functions, species abundance, or composition of marine or freshwater wetlands or plant communities of Cook Inlet. A large gas release would have negligible impacts to coastal and estuarine habitats, unless there is an associated explosion or ignition, in which case impacts to wetlands and vegetation could be major. Spill response and cleanup activities, or spill drills, are expected to have negligible impacts to coastal and estuarine habitats, particularly if cleanup activities occur during the winter season.

A-3.4 Invertebrates and Fish

Exposure to oil or its toxic components causes lethal to sublethal toxicity to marine invertebrates. Impacts of oil on marine invertebrates vary depending on level of exposure, life history, feeding behavior, and ability of a species to metabolize toxins. Benthic and planktonic invertebrates are exposed to oil in different ways and vary in their ability to avoid exposure. Impacts from a spill can occur through exposure to toxins, changes in oxygen and light availability in the water, and physical damage to organisms by settled oils. Adverse impacts to fish and fish habitat from spills can occur in both freshwater and marine environments. Impacts can occur through exposure of various life stages of fish to toxins, impacts to prey and interference with access to important habitat areas. Although oil is toxic to fish at high concentrations, certain species are more sensitive than others, and oil can have toxic effects even in low concentrations. Potential impacts to marine invertebrates and fish related to accidental spills include the following:

- Direct toxic effects to marine invertebrates can include lethal or sublethal consequences such as impacts on biomass and community composition, as well as impacts on behavior, reproduction, growth and development, immune response, and respiration (Auffret et al., 2004; Bellas et al., 2013; Blackburn et al., 2014; Hannam et al., 2010).
- 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 (Blackburn et al., 2014; Dupuis and Ucan-Marin, 2015). The level of toxicity is influenced by how marine invertebrates are exposed, their life history, feeding behavior, and ability of a species to metabolize toxins.
- Chronic exposure to oil and its byproducts can cause cellular damage and impair feeding, mobility, reproduction, growth, and development in marine invertebrates (Bellas et al., 2013; Blackburn et al., 2014).
- Indirect toxic effects can occur through the inhibition of air-sea gas exchanges and hypoxia from the degradation of oil (Abbriano et al., 2011; Blackburn et al., 2014; Ozhan et al., 2014).
- Other lethal or sublethal impacts include physical smothering of organisms by settled oil and reduced photosynthesis through changes in light penetration into the water column (Blackburn et al., 2014; González et al., 2013; Ozhan et al., 2014).
- Oil or its toxic components in plankton can biomagnify/bioaccumulate through food webs and affect higher trophic levels (Blackburn et al., 2014). This can reduce prey availability for fish and other marine animals.
- Immediate mortality or other sublethal impacts to fish can occur, such as abnormal development and growth, reproductive damage, and behavioral changes (Carls et al., 1999; Dupuis and Ucan-

Marin, 2015; Hjermann et al., 2007; Incardona, 2017; Nahrgang et al., 2016; Rice et al., 2000; Short, 2003).

- Toxic concentrations can build up in coastal areas where oil is trapped in shallow bays and inlets, and presence of oil can interfere with fish spawning or access to spawning grounds (Heintz et al., 2000; Wertheimer et al., 2000).

Additional discussion of the general impacts of oil and gas on invertebrates and fish is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Sections 4.2.4 and 4.2.5).

A-3.4.1 Small Oil Spills (<1,000 bbl)

Small spills would have localized adverse impacts to planktonic and benthic invertebrates and fish. Toxic effects on organisms could occur in the immediate area of a spill. The majority of small spills are estimated to be less than 50 bbl (EIS, Table 3-1), and the impacts on invertebrates and fish would be short-term and localized to the spill area. Impacts to the overall marine invertebrate and fish populations of Cook Inlet would not likely be detectable for small, isolated accidental spills, especially if contained by platform or ice, or are cleaned up before they enter the water column. Most refined small spills that reach the water column will evaporate and disperse within days, which would limit the number of individuals exposed to the toxic effects. A crude oil spill of 125 bbl would likely affect a larger area, and therefore a greater number of fish and invertebrates, but population level impacts from that isolated event are not anticipated.

Chronic, repeated small oil spills could have an extended adverse effect on invertebrates and fish because residual oil can build up in sediments and affect living marine resources. However, these impacts would be limited to discrete areas around the development facilities. Planktonic invertebrate species would quickly repopulate the area via currents and no long-term population impacts are expected. Pelagic fish are expected to avoid the area, thus limiting the number of individuals exposed. Benthic invertebrate and fish communities that are exposed to chronic small spills may experience impacts for multiple generations. These impacts to benthic communities would be limited to the immediate area of the development facilities and would not result in population-level impacts when considering Cook Inlet as a whole. Over the life of the E&D Scenario, invertebrate and fish communities would not generally experience widespread, multi-year, multi-generational impacts.

A-3.4.2 Large Oil Spill (≥1,000 bbl)/Gas Release

Impacts of a large, 3,800 bbl spill on invertebrates and fish would be of greater magnitude and severity than from a small spill. In general, a greater area would be oiled, and more individuals would be impacted depending on the location, volume, trajectory of the spill, and the time of year it occurs. Oil spilled on landfast ice may not reach the water column in the winter, however, a spill occurring in winter may persist for a longer period than during ice-free conditions (Drozdowski et al., 2011), resulting in larger impacts on invertebrates and fish if it is trapped under the ice. The conditional analysis below shows resource areas that have the highest chances of contact for spill locations adjacent to them.

Spilled oil would dilute slowly when ice is present, and more swiftly in open water conditions. Most VOCs in spilled oil would evaporate within a couple of days, although some of the remaining oil could adhere to particles and sink to the seafloor and remain in the sediment. A large crude oil spill would persist longer in the environment and could result in greater impacts to benthic invertebrates and fish than small spills. Migratory and anadromous fish, including several species of forage fishes, could experience adverse effects from a large oil spill in spawning and rearing habitats. Impacts of a large spill in nearshore intertidal areas could persist for generations and might have additive impacts by affecting more than one life stage. Adverse impacts from a large spill, including mortality and community structure changes, could be widespread and persist for multiple generations.

A large gas release and potential ignition or explosion could cause death or physical damage to organisms in the immediate vicinity. Fish mortality associated with a gas release could range from only a few to hundreds of individuals. However, such an event would likely involve several species of fish and invertebrates, with no expected population-level impacts. Overall, mortality associated with a release is expected to have very short-term impacts on invertebrates and fish in the immediate area and little to no impacts on the overall invertebrate and fish communities.

A-3.4.2.1 Oil Spill Risk Analysis

BOEM identified 5 lower trophic (fish and invertebrates that are food for other animals) resource areas and 104 anadromous fish resource areas for the analysis (Ji and Smith, 2021; Tables A.1-2, and A.1-3; Figures B-2a; B-3a–d, and B-4a.1). The OSRA acronyms are: ERA Environmental Resource Area; LS Land Segment; and GLS Grouped Land Segment.

Conditional Probabilities. Conditional probabilities help illustrate the biologically important areas that may be contacted and assume that a spill occurs. Table A5 and Figure A3 and Figure A4 show resource areas with a ≥0.5 percent chance of contact in summer or winter. This analysis focuses on resource areas that have a ≥6 percent chance of contact. Depending upon the timing of seasonal ice and location of the spill, seasonal ice could affect the chance of a spill contacting nearshore resource areas.

Summer. All five of the ERAs identified for lower trophic organisms have ≥6 percent chance of being contacted by a spill occurring in the summer or winter (Table A5; ERAs 11, 153–155, GLS 138); two have ≥50 percent chance. In contrast, only 10 of 104 anadromous fish resources exceeded a 6 percent chance of contact (Table A5; LSs 28, 30–36, 56, 61, and 62). These LSs, which identify important spawning stream locations, are located adjacent to the middle of the Proposed Lease Sale Area, and with the exception of the area near Anchor Point, occur on the western edge of the Proposed Lease Sale Area. The chance of contact for lower trophic ERAs and GLSs ranged from ≥0.5–89 percent, while LSs that contained anadromous fish streams had comparatively low chances of contact that ranged from ≥0.5–20 percent.

In general, chances of contact are higher for an area when the spill originates close to the resource. For example, for invertebrates, the Barren Islands (155) have the lowest chance of contact and Polly Creek Beach (153) has the highest, except when the spill occurs in the lower portion of the Proposed Lease Sale Area. Oil spills originating from the upper and middle part of the Lease Sale Area are more likely to contact important resource areas than spills originating from the lower part of the Lease Sale Area. Regardless of where the spill occurs, Augustine (11), important for lower trophic organisms, shows consistent chances of contact, with higher chances of contact for spills occurring closest to the ERA. Of anadromous fish resources, Chinitna Bay has the most consistent risked contact, although Redoubt Point and Tuxedni Bay had the highest likelihoods to be contacted by a spill occurring in the summer and winter, respectively.

Winter. In general, the resource areas important for lower trophic organisms that are contacted by a large winter spill are the same as the summer, with relatively similar probabilities of contact. Some areas are higher, and some areas are lower, likely due to the expected influence of ice. The Clam Gulch (138) and the LS near Anchor Point (56) decrease to <6 percent in winter.

Table A5: Highest Percent Chance of a Large Oil Spill Contacting Lower Trophic Level or Anadromous Fish Resources (Assuming a Large Spill Occurs)[1]

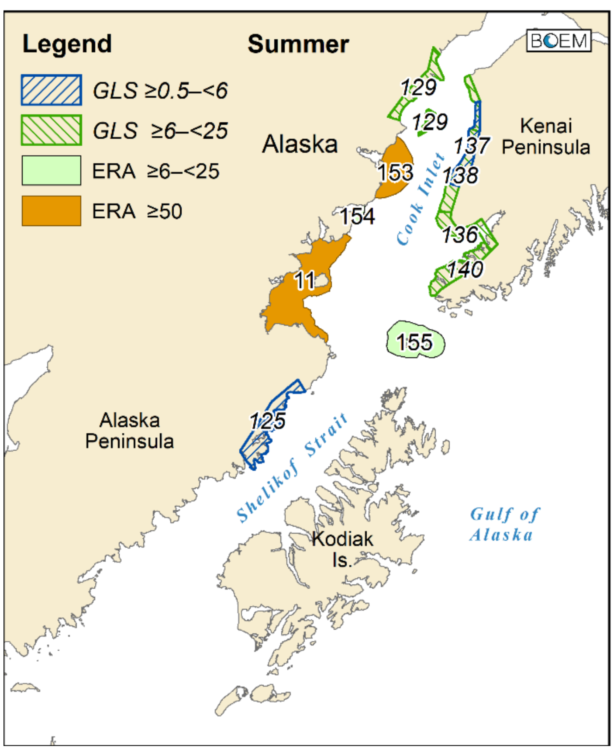
OSRA Resource Type2	Highest Chance of Contact	Summer: 30 days	Winter: 30 days
ERA	≥0.5–<6	--	--
ERA	≥6–<25	154, 155	154 155

Table A5: Highest Percent Chance of a Large Oil Spill Contacting Lower Trophic Level or Anadromous Fish Resources (Assuming a Large Spill Occurs)[1]

OSRA Resource Type2	Highest Chance of Contact	Summer: 30 days	Winter: 30 days
ERA	≥25–<50	--	--
ERA	≥50	11, 153	11, 153
GLS	≥0.5–<6	--	--
GLS	≥6–<25	138	138
LS	≥0.5–<6	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	21, 22, 23, 24, 25, 26, 27, 37, 38, 39, 40, 54, 55, 57, 58, 60, 61, 63, 81, 82, 83, 84, 85, 86, 87, 88
LS	≥6–<25	28, 30, 31, 32, 33, 35, 36, 56, 61, 62	28, 30, 31, 32, 33, 34, 35, 36, 56, 62

Names of ERAs Contacted: 11 Augustine; 153 Polly Creek Beach; 154 Chinitna Bay; 155 Barren Islands.
Names of GLSs Contacted: 138 Clam Gulch Critical Habitat
Names of LSs Contacted: 18 Alinchak Bay, Cape Kekurnoi, Bear Bay; 19 Cape Kubugakli, Kashvik Bay, Katmai Bay; 20 Amalik, Dakavak and Kinak Bays, Cape Iiktugitak, Takli Island; 21 Kaflia Bay, Kukak Bay, Kuliak Bay, Missak Bay; 22 Devils Cove, Hallo Bay; 23 Cape Chiniak, Swikshak Bay; 24 Fourpeaked Glacier; 25 Cape Douglas, Sukoi Bay; 26 Douglas River; 27 Akumwarvik Bay, McNeil Cove, Nordyke Island; 28 Amakdedulia Cove, Bruin Bay, Chenik Head; 29 Augustine Island; 30 Rocky Cove, Tignagvik Point; 31 Iliamna Bay, Iniskin Bay, Ursus Cove; 32 Chinitna Point, Dry Bay; 33 Chinitna Bay; 34 Iliamna Point; 35 Chisik Island, Tuxedni Bay; 36 Redoubt Point; 37 Drift River, Drift River Terminal; 38 Kalgin Island; 39 Seal River, Big River; 40 Kustatan River,West Foreland; 54 Clam Gulch, Kasilof; 55 Deep Creek, Ninilchik, Ninilchik River; 56 Cape Starichkof, Happy Valley; 57 Anchor Point, Anchor River; 58 Homer, Homer Spit; 59 Fritz Creek, Halibut Cove; 60 China Poot Bay, Gull Island; 61 Barabara Point, Seldovia Bay; 62 Nanwalek, Port Graham; 63 Elizabeth Island, Port Chatham, Koyuktolik Bay; 81 Shuyak Island; 82 Bluefox Bay, Shuyak Island, Shuyak Strait; 83 Foul Bay, Paramanof Bay; 84 Malina Bay, Raspberry Island, Raspberry Strait; 85 Kupreanof Strait, Viekoda Bay; 86 Uganik Bay, Uganik Strait, Cape Ugat; 87 Cape Kuliuk, Spiridon Bay, Uyak Bay; 88 Karluk Lagoon, Northeast Harbor, Karluk.

Notes: -- No highest percent chance in this range.
[1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all resource areas with <0.5% chance of contact are not shown.
[2] Invertebrates and Fish are represented by ERAs and GLSs. Anadromous Fish resources areas are represented by LSs.
Source: Ji and Smith (2021).



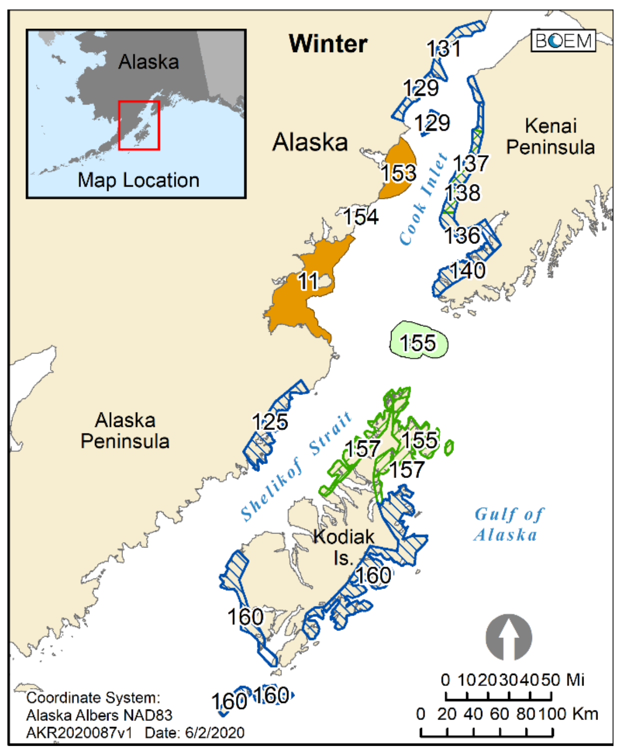


Figure A3: Location and ID number of Invertebrate Resource Areas (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

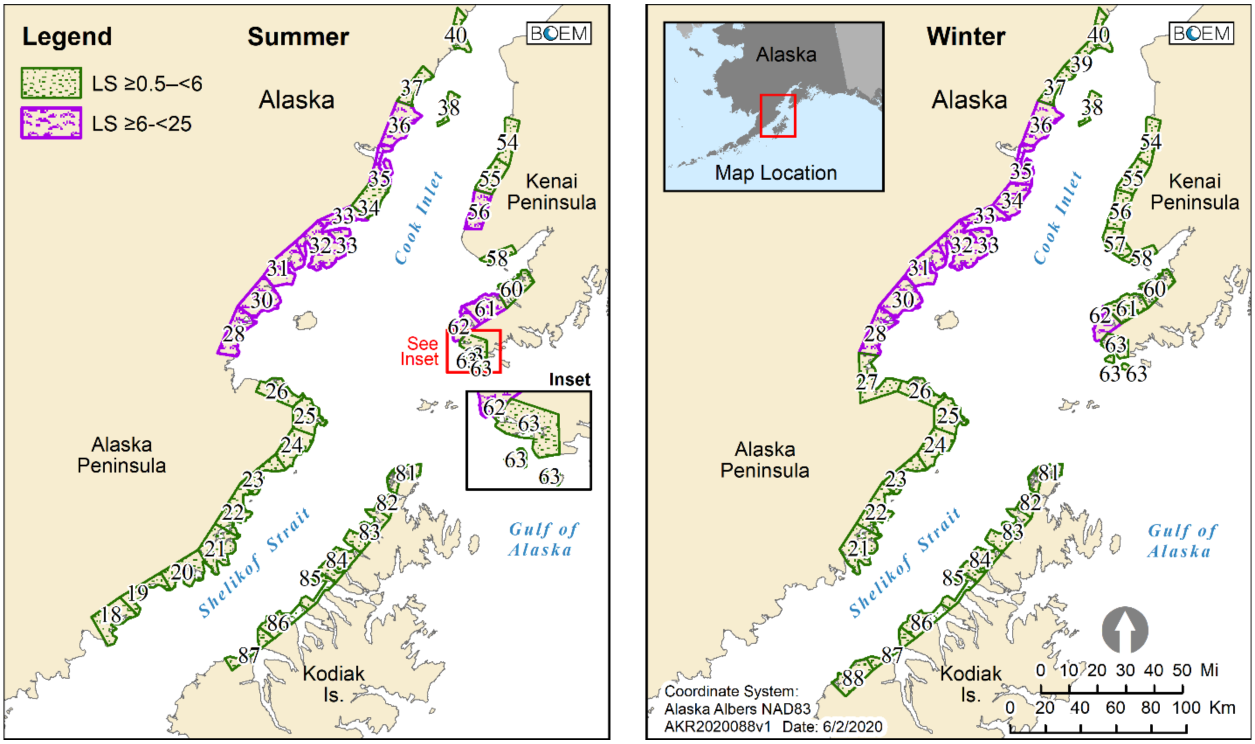


Figure A4: Location and ID number of Anadramous Fish Resource Areas (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

<u>Combined Probabilities</u>. The resource areas for lower trophic organisms that are impacted have a chance of occurrence and contact are generally the same ones described in the conditional analysis, but the magnitude of contact is reduced due to factoring in the probability of a large spill occurring. Most areas have a combined probability of occurrence and contact <1 percent within 30 days; the highest is Polly Creek Beach (153), which has an 11 percent chance within 30 days.

A-3.4.3 Spill Drills and Response Activities

Spill drills, including GIUEs, would impact invertebrates and fish through vessel traffic, noise, and discharges, and possibly through testing of mechanical recovery methods. Spill response activities could include mechanical recovery methods and in-situ burning, as well as use of dispersants (BOEM, 2019). Increased vessel traffic, with corresponding increases in vessel discharges and noise, would also be associated with spill cleanup. If cleanup operations include sections of the beach or intertidal zones, access to spawning habitat for some species may be restricted.

Spill impacts and cleanup operations would be influenced by time of year. Response efforts would be both hindered and aided by the presence of ice. Ice would contain a spill, concentrate it, and may act as a barrier to shoreline oiling. However, ice may also make a spill difficult to detect, locate, and access. Volatile components of the spill would be more likely to freeze into the ice rather than evaporate.

Physical damage to invertebrates and fish from containment and collection procedures could occur. Lethal impacts may occur to planktonic organisms but are not expected to be detectable at the population level. 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 occur 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 invertebrates and fish would not likely be affected by mechanical recovery activities occurring at the surface. In-situ burning could impact organisms in the immediate area due to residue from the burn sinking to the bottom. Death of planktonic invertebrates and pelagic fishes that did not move away from the spill is possible in the immediate burn area. At the seafloor, habitat can be altered by residue from a burn. Some benthic organisms may be smothered. Impacts from mechanical recovery or burning are expected to be short-term and localized to the area of the spill.

The use of dispersants has been shown to increase the exposure of fish eggs to toxic levels of hydrocarbons because the dispersants make the oil more easily cross the egg membrane (Ramachandran et al., 2004). Dispersants used in spill response activities can result in greater toxic impacts to invertebrates than crude oil alone (Almeda et al., 2013; Lee et al., 2012), and can also have negative impacts on the food web (Lee, 2013;Ortman et al., 2012; Trannum and Bakke, 2012).

Impacts from a large spill response could be long-lasting and widespread for fish and invertebrate communities if a large spill occurs near spawning grounds or dispersants are used. Impacts from small spill response and spill drill activities would be localized and short-term, especially if pelagic individuals are able to avoid areas of activity. Impacts to the benthic community from spill response and spill drills would be limited spatially by the settling of oil and dispersants, and no population-level impacts are expected to be observable for the Cook Inlet overall.

A-3.4.4 Conclusion

Impacts from small spills would be minor because invertebrate and fish communities in the Cook Inlet would not generally experience widespread, multi-year, multi-generational impacts and there would not be a clear, long-lasting change in this resource’s function in the ecosystem. In contrast, a large oil spill could have widespread and long-lasting, and therefore moderate, impacts depending on the season and location of the spill. Spills originating in the upper and middle portion of the Proposed Lease Sale Area have the greatest potential to affect fish and invertebrates through contact with oil. A large gas release would have negligible impacts on the overall community structure of fish and invertebrates in Cook Inlet. Spill response and cleanup could have minor to moderate impacts on fish and invertebrates, depending on where the spill is located and if dispersants are used. Spill drills are short-term and localized and are expected to have negligible impacts on fish and invertebrates.

A-3.5 Birds

Spills can have lethal and sublethal physiological and behavioral effects on birds, and indirect impacts via contamination and disturbance of prey resources and habitats. The impacts of oil spills on birds are well documented and the evidence for these impacts is briefly discussed below. In particular, potential oil spill impacts to birds include the following:

- Mortality or reduced fitness resulting from direct contact (Balseiro et al., 2005; Haney, Geiger, and Short, 2014a, b; Maggini et al., 2017; O’Hara and Morandin, 2010).
- Toxic (lethal or sublethal) reactions from inhalation, direct ingestion, or ingestion of contaminated prey (Balseiro et al., 2005; Bursian et al., 2017).
- Effects to migration and reproduction via physiological damage to adults (Dorr et al., 2019; Golet et al., 2002).
- Other productivity effects, such as via oil contamination of eggs and nest material or adults delivering contaminated prey to chicks (Stout et al., 2018; Zuberogoitia et al., 2006).
- Modified prey abundance (Esler et al., 2002; Golet et al., 2002; Irons et al., 2000).

- Damage to and displacement from foraging or molting habitat (Day et al., 1997; Esler et al., 2002; Henkel et al., 2014; Wiens et al., 2004).
- Disturbance and displacement of breeding or migrating birds, and nest failure from cleanup activities in nesting habitat (Andres, 1997; Fraser and Racine, 2016; DWH Trustees, 2016).

Additional discussion of the general impacts of oil and gas on birds is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.8).

A-3.5.1 Small Oil Spills (<1,000 bbl)

Most of the 410 small spills are not expected to impact migratory birds. This is because some spills may be associated with vessels, vehicles, and heavy equipment, but birds typically move away from operational disturbances (EIS Section 4.7.2).

Some small spills, however, could affect foraging or nesting birds, localized areas of open water and wetland nesting habitat, or marine prey (Sections A-3.2.1, A-3.3.1, and A-3.4.1). The greatest impact could occur if there was chronic annual oiling in an important forage area or if the 125-bbl crude oil spill occurred where hundreds or more birds are densely concentrated or rapidly moving through an area (Fraser and Racine, 2016). Various groups of birds that could be immediately vulnerable include spring migrants in an open ice lead; dense flocks of foraging birds in pelagic waters or in summer near a seabird colony; molting ducks concentrated in the post-breeding period in nearshore waters; or migrating shorebirds and waterfowl staging in spring or fall in coastal habitat. Healthy populations would withstand the short-term and localized impacts of a one-time event (Henkel, Sigel, and Taylor, 2012).

A-3.5.2 Large Oil Spill (≥1,000 bbl)/Gas Release

The same bird concentrations described above as vulnerable to small spill impacts would likely experience the highest numbers of direct mortality if they were contacted by a large, 3,800 bbl spill. The species most vulnerable to a large marine spill are mostly pelagic seabirds, not only because of their long exposure time at sea, but because their long-lived, delayed maturation, and limited offspring life history strategies mean that the loss of relatively few breeding age adults can have population-level effects (Fraser and Russell, 2016). Additionally, harm to habitats and prey that could result from a large spill (Sections A-3.3 and A-3.4) could produce impacts to more birds and more bird populations even if those birds are not initially present during spill contact. As an example, a large spill may initially only contact (i.e., affect) seabirds and phalaropes in offshore waters and reach coastal mudflats at a time before abundant coastal species are present, but large numbers of staging shorebirds and waterfowl could later arrive on the mudflats and be affected by lingering oil or reduced or contaminated prey. This would not only increase the number of affected individuals but also the number of species and populations affected.

Spill timing and location as well as characteristics of spill response efforts influence the magnitude and extent of spill impacts to birds. For example, a terrestrial pipeline spill would have localized impacts on a variety of landbirds, shorebirds, waterfowl, raptors, and cranes if it occurred in preferred wetland habitat during the breeding season or if impacts to habitat persisted into the breeding season. Impacts to most locally breeding birds would generally be short-term and confined to the local area because most of these species have large and widely dispersed breeding distributions. However, a marine spill that occurred, for example, when certain seabirds are experiencing, or struggling to recover from, one of the increasingly common widespread breeding failures or starvation-related die-offs could potentially keep the population depressed for several years. A spill that contacted or decreased food availability for some of the largest colonies or flocks (e.g., Barren Islands colonies or molting or wintering Kamishak Bay flocks) could potentially impact enough birds of a given population or populations to affect them for several years. The combined analysis below estimates that the highest chances of occurrence and contact may be considered relatively low (i.e., <10 percent), but does include high population areas (e.g., Barren Islands). Contact with a large proportion of a vulnerable population or long-term damage to its habitat, such as Pribilof Island rock sandpiper and its wintering habitat in places like Redoubt Bay would have long-term, potentially severe, impacts. The combined analysis does show Redoubt Bay as among the areas with the highest, albeit still <4 percent, chance of a spill occurrence and contact.

Impacts to birds would not only be long-term but potentially widespread if dense flocks of staging, molting, or wintering birds are affected. This is because flocks during these periods are typically made up of migratory individuals from multiple widespread breeding populations. Birds' trophic relationships with multiple habitats can complicate and widen a spill's impacts (Henkel, Sigel, and Taylor, 2012). The conditional analysis below shows chances of contact are highest to some high-use breeding, molting, wintering, and migratory stop-over areas and pelagic resources.

A natural gas release would have potential to harm birds, but only if large numbers happened to be in the immediate vicinity at the time of certain types of release. A gas release with an ignition and explosion could physically injure staging or diving flocks of birds. Also, if the gas release was ignited at night or during a period of low visibility in spring or fall, the bright light could attract, disorient, and cause the collisions of many migrating species, including gulls and Endangered Species Act (ESA) listed Steller's eiders. Collision of a large flock of a vulnerable population could potentially have widespread and long-lasting impacts, but the chance of all predictive factors occurring together (e.g., explosion, low visibility conditions during heavy migration, and presence of a vulnerable population) is unlikely. Any flocks that actually were to fly through the release of natural gas would be unlikely to experience long-term impacts because of the quickly dissipating nature of the gas in air, and very low level of hydrogen sulfide or other toxins (Shell Gulf of Mexico Inc., 2015).

A-3.5.2.1 Oil Spill Risk Analysis

BOEM identified 48 bird resource areas for analysis (Ji and Smith, 2021; Table A.1-8; and Figures B-2a–d, and f– h; B-3a–c; B-4b). The OSRA acronyms are: ERA Environmental Resource Area; LS Land Segment; LA Launch Area; and PL Pipeline.

Conditional Probabilities. Table A6 and Figure A5 show that if a large spill occurred from any location in the summer or winter it would contact up to 21 of the 48 resource areas with a ≥0.5 percent chance. Up to 9 of those areas, have a ≥10 percent chance of contact (Ji and Smith 2021, Tables A-2.24, and A-2.44). Outer Kachemak Bay Important Bird Area (IBA) (145) and Lower Cook Inlet 153W59N IBA (146) are the only areas with ≥50 percent chance of contact, and up to 97 percent, depending on spill location (Ji and Smith 2021, Table A-2.24 and A.2.44). Depending on the season and spill location 4 resources areas in or adjacent to the Proposed Lease Sale Area are contacted ≥25–<50 percent. Those areas with <0.5 percent chance of contact are mostly coastal areas south of Shelikof Strait, or on the eastern shores of the Kodiak Archipelago and Kenai Peninsula. In general, there is a lower chance of winter spills contacting bird resource areas than summer spills because there is a temporal aspect to most bird resource areas, and seabird breeding colony sites are not active during winter.

Summer. The areas with the greatest chance of contact (>25 percent) for a summer spill are Outer Kachemak Bay/IBA (145), Kamishak Bay IBA (136), and Tuxedni Island Colony IBA (138), which means pelagic seabirds, seaducks, and phalaropes foraging offshore of the mouth of Kachemak Bay, numerous seabird colonies in Tuxedni Bay and Kamishak Bay, and molting seaducks in Kamishak Bay will be some of the most vulnerable marine birds. With a 6–<25 percent chance of contact, among the next most vulnerable would be Redoubt Bay and Shaw Island seabird colonies (140 and 135), seabirds foraging in Lower Cook Inlet (146), Steller's eider in nonbreeding habitat in the Clam Gulch vicinity (144), and the quarter of a million seabirds, including over 100,000 fork-tailed storm petrels and 17 other species, that nest on the Barren Islands (147 and 148) (Kettle, 2017). The OSRA estimates a >0.5–<6 percent chance that a summer spill would contact the foraging areas of western Kodiak Island (ERAs 111 and 112, and LS 87), seabird colonies in Shelikof Strait (130, 132, 133, and 134) and Semidi Islands (122), and extend east of Kodiak into Gulf of Alaska foraging areas (119).

Winter. The winter chances of contact follow roughly the same patterns as discussed above for a summer spill, with the following notable differences. Fewer resource areas would be contacted because the spill would have <0.5 percent chance of extending as far to the south down Shelikof Strait as in summer. Figure A2 shows that a summer spill may have >0.5 percent chance of contact as far south as Alinchak Bay, Cape Kekumoi, Bear Bay (18), while a winter spill may only have >0.5 percent chance of contact as far south as Kaflia, Kukak, Kuliak, and Missak Bays (21). Furthermore, many bird resource areas are seabird colonies with a temporal component, meaning that large numbers of birds are most vulnerable in those areas only during the summer breeding season. There is still a >0.5 percent chance that a winter spill from the southern LAs or PLs would extend to the Gulf of Alaska (151) where hundreds of thousands of seabirds forage year-round.

Table A6: Highest Percent Chance of a Large Oil Spill Contacting Bird Resources (Assuming a Large Spill Occurs)[1]

OSRA Feature Type	Highest Percent Chance Contact	Summer: 30 days	Winter: 30 days
ERA	≥0.5–<6	111, 112, 119, 122, 130, 132, 133, 134, 137, 149, 151	151
ERA	≥6–<25	135, 139, 140, 144, 146, 147, 148	140, 144
ERA	≥25–<50	136, 138	137, 139
ERA	≥50	145	145, 146
LS	≥0.5–<6	87	87
Names of ERAs Contacted: 111 NW Afognak Is IBA; 112 Uganik And Viekoda Bay IBAs; 119 Gulf Of Alaska Shelf IBA; 122 Semidi Islands Marine IBA; 130 South Alinchak Bay Colony; 132 Amalik Bay Colonies IBA; 133 Ninagiak Is Colonies; 134 Kiukpalik Is ; 135 Shaw Is Colony; 136 Kamishak Bay IBA; 137 Kamishak Bay STEI Habitat; 138 Tuxedni Is Colony IBA; 139 Tuxedni Bay IBA; 140 Redoubt Bay IBA; 144 Clam Gulch STEI Habitat.; 145 Outer Kachemak Bay/IBA; 146 Lower Cook Inlet 153W59N; 147 Barren Islands Marine IBA; 148 Barren Islands Colonies IBA; 149 SW Kenai Pen Marine IBA; 151 Gulf of AK Shelf 151W58N IBA Names of LSs Contacted: 87 Uyak Bay			

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all resource areas with <0.5 percent chance of contact are not shown.
Source: Ji and Smith (2021).

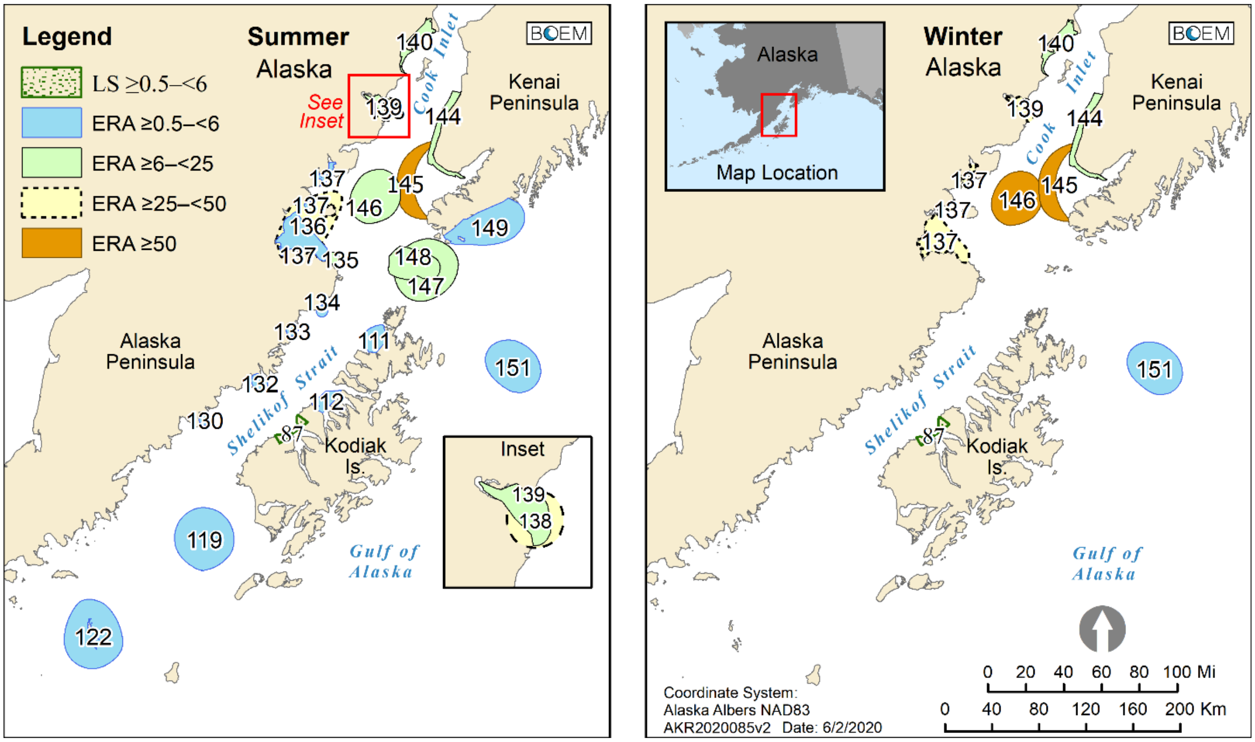


Figure A5: Location and ID number of Bird Resource Areas: (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days) Summer and Winter

Combined Probabilities. The OSRA estimates the highest chance of a large spill both occurring and contacting an important bird resource area is 9 percent within 10 days for Outer Kachemak Bay IBA (145) (Ji and Smith, 2021, Table A.2-61). There is a 1–5 percent chance of a large spill occurring and contacting 9 other resource areas within 30 days, including summer colony activity of Kamishak Bay IBA (136), Tuxedni Island Colony IBA (138), Barren Islands Marine IBA (147), and Barren Islands Colonies IBA (148); post-breeding and winter shorebird and waterfowl activity of Tuxedni Bay IBA (139); wintering seabird habitat of Lower Cook Inlet 153W59N IBA (146); and Steller's eider (and other seaduck) wintering habitat of Kamishak Bay (137) and Clam Gulch (144) (Ji and Smith, 2021, Table A.2-61). Redoubt Bay IBA (140) falls into this 1–5 percent category as well where seabird, waterfowl, and shorebird resources could be at risk year-round. Redoubt Bay IBA shorebirds include a large proportion of the world's population of Pribilof Island rock sandpiper which shelters in Redoubt and Tuxedni bays when the coldest winter days push them south from the Susitna Flats/Trading Bay areas (Ruthrauff, Gill, and Tibbitts, 2013).

A-3.5.3 Spill Drills and Response Activities

Spill drills, including GIUEs, would be infrequent, localized at areas of high human activity, and are expected to have little effect on birds. Spill response operations, however, can impact birds. The dense concentrations of birds most vulnerable to oil can also be fouled by burn residue from in-situ burning and the emulsions of oil created by dispersants and suspended in the water column (Chen and Denison, 2011; Fritt-Rasmussen, Wegeberg, and Gustavson, 2015). Depending on timing and location, large concentrations of nesting, molting, or staging birds may be disturbed or displaced during spill cleanup operations in or near oil-affected onshore and nearshore habitats. Nests, especially those of shorebirds, waterfowl, landbirds, and cranes, could be destroyed (Andres, 1997; Harwell and Gentile, 2006; Jenssen, 1994). Besides spill characteristics, the size and extent of spill response impacts on birds ultimately depends on techniques, siting in relation to bird seasonal timing and densities, efficacy of cleanup, and how many seasons response activities may last.

A-3.5.4 Conclusion

Most accidental small spills or spill drills would be localized and limited in area and have no more than minor impacts on birds. A large spill that contacts many marine birds or reaches coastal areas could have impacts that are more persistent, require remediation, and impact a greater number of birds and species. If it occurred during a period of high bird use in coastal waters, it would be expected to foul large numbers of staging and migrating birds from widespread populations. Foraging, resting, and sheltering habitat for staging, migrating, and nesting birds would be fouled, with mechanical damage to foraging habitat and possibly nests during the cleanup process. Some populations that experience spill-related effects to large numbers of birds would be expected to take several years to recover. Long-term damage to otherwise vulnerable seabird breeding populations (e.g., chronically failing murres and black-legged kittiwakes) would be possible. The long-term and widespread impacts from a large spill would be considered less than severe, and therefore moderate, for most species because the various populations affected would be expected to eventually recover. Depending on location and timing however, contact with wintering rock sandpipers or their habitat would have potentially major population-level impacts. Spill response would typically have short-term and localized displacement-related impacts, but impacts would range up to long-term and moderate if involving both marine and land-based activities when large concentrations of birds are present or nesting. In the unlikely event that migrating or staging birds were within the vicinity of a gas explosion, a few hundred individuals from disparate populations could be killed, which would have a localized and minor level of impact on bird resources as a whole.

A-3.6 Marine Mammals

Oil spills can affect marine mammals, their habitats, and their prey through a variety of direct and indirect pathways which can have both long-term individual impacts and population-level impacts depending on the spill size, location, and environmental factors present at the time of the spill (Helm et al., 2015). An oil spill affects each group of marine mammals differently. Marine mammals live in offshore and nearshore waters and could be exposed to spilled oil at sea. Seals, sea lions, and sea otters can also be exposed to spilled oil at terrestrial nearshore areas. The effects of oil spills on marine mammals have been observed in studies on spill effects and from controlled experiments on marine mammals. These effects include, but are not limited to, the following:

- Short- and long-term respiratory effects such as pulmonary emphysema and inflammation and infection of respiratory tissue through inhalation of VOCs from crude oil or natural gas (Geraci and St. Aubin, 1990; Godard-Codding and Collier, 2018; Hansen, 1985; Helm et al., 2015; Neff, 1990; Schwacke et al., 2014).
- Inflammation, ulcers, bleeding, and damage to organs from ingestion of oil (and dispersants) directly or via contaminated prey. However, some marine mammals may metabolize and eliminate hydrocarbons (Engelhardt, 1982, 1983; Geraci and St Aubin, 1990; Kooyman, Gentry, and McAlister, 1976).
- Irritation, inflammation, or necrosis of skin, as well as chemical burns of skin, eyes, and mucous membranes from dermal contact (Hansen, 1985; Engelhardt, 1982, 1983; Werth, Blakeney, and Cothren, 2019).Venues of dermal contact include oiling of whale baleen, fur on sea otters, oiling of skin, eyes, conjunctive membranes, and cetacean blowholes.
- Elevated cortisol and altered endocrine levels in some individual marine mammals from exposure to hydrocarbons (Geraci and St Aubin, 1990).
- Short- and/or long-term reductions in prey availability, habitats, and populations (USFWS, 2015a; Section A-3.4).

- Disruption of social groups leading to decreased survival and lowered reproductive success (Geraci and St Aubin, 1990; Matkin et al., 2008).
- Habitat degradation (Geraci and St Aubin, 1990; Hoover-Miller, Parker, and Burns, 2001; Helm et al. 2015).
- Delayed recovery of habitat from chronic exposure to residual oil components, which could produce lingering effects on marine mammals (Peterson et al., 2003).
- Disturbance or displacement from cleanup crews, vessels, or aircraft during spill response activities (USFWS, 2015a NMFS, 2019; Ziccardi et al., 2015).

Additional discussion of the general impacts of oil and gas on whales, seals and -other marine mammals is provided in the respective sections below and is detailed in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.6).

A-3.6.1 Cetaceans

Beluga, killer, and minke whales, Dall's and harbor porpoises, and Pacific white-sided dolphins are resident cetaceans that occur in Cook Inlet throughout the year. Fin, gray, and humpback are migrant cetaceans that occur in Cook Inlet from spring to fall and could only be directly affected by oil spills in that window of time. Fin, gray, and humpback whales migrate from and to their wintering areas in spring and fall respectively. Gray whales usually pass by the outlet of Cook Inlet on their way to and from their primary summer feeding areas in the Bering and Chukchi seas. Some fin and humpback whales return specifically to Cook Inlet for summer feeding, while others periodically show up near the Lease Sale Area to feed. Cook Inlet beluga whales spend most of the ice-free months feeding on aggregations of anadromous fish in upper Cook Inlet, north of Kalgin Island. When ice begins forming in the inlet, these whales relocate to lower Cook Inlet. Killer and minke whales, Dall's and harbor porpoises, and Pacific white-sided dolphins occasionally show up in different parts of Cook Inlet throughout the year, as sea ice permits.

A-3.6.1.1 Small Oil Spills (<1,000 bbl)

Small spills in winter would occur when most whales are absent. Beluga whales would be present in Lower Cook Inlet, as might a few killer whales, Dall's and harbor porpoises, and Pacific white-sided dolphins. Small, refined spills dissipate in less than 2 days while portions of a 125-bbl crude oil spill could persist up to a month (Table A1). These small spills would be localized in extent and could be cleaned up.

In the event of a small spill during summer, individual whales or their prey could come into contact with oil. Temporary exposures to small spills over highly localized areas would be infrequent with few consequences. Since oil poorly adheres to cetacean skin, chronic impacts from epidermal contact would be unlikely for them (Engelhardt, 1983; Geraci and St Aubin, 1986). Furthermore, small spills occurring over localized areas could only affect small quantity of prey resources. For these reasons the impacts of small spills would not affect cetacean populations and would have a very limited ability to affect individual cetaceans. Because small spills dissipate or are cleaned up rapidly, the likelihood of impacting cetaceans or their populations would be further reduced.

A-3.6.1.2 Large Oil Spill (≥1,000 bbl)/Gas Release

Large spill (3,800 bbl) impacts to whales would depend on the location, timing, duration, sea and climatic conditions, and response to the spill event. There is little potential to impact large numbers of cetaceans which are few in number inside lower Cook Inlet at any time; however the small population sizes for belugas, humpback, fin and North Pacific right whales in or near Cook Inlet means adverse impacts to a small number of individuals could lead to a cascade of impacts to their populations. The magnitude of such a cascade would vary based on the type of impact, the overall stock/population size, number of individuals affected, and the genetic diversity in the population. The conditional analysis below shows probability of contact is highest for cetacean resource areas near the outlet of Cook Inlet Shelikof Strait, and the southern Kenai coastline in summer. The probability of a large spill contacting summer Critical Habitat for Cook Inlet beluga whales, or areas in the upper inlet where they usually occur in summer, remains low so individuals from their population are less likely to be impacted by a large summer spill than individuals of other cetacean species who regularly occur in the Lease Sale Area and nearby areas. A large spill in winter could affect belugas and their winter Critical Habitat areas, and such an event could have major impacts on the stock due to the small population size and their restricted winter range in the inlet.

Although individuals may experience temporary and/or permanent injury and non-lethal impacts through inhalation, ingestion, or contact, mortality would be unlikely. Temporary displacement from high value feeding and resting areas might occur, depending on spill characteristics. Whale prey (schooling forage fish and zooplankton) could be reduced or contaminated leading to modified whale feeding distributions. However, reduction or contamination of food sources would be localized relative to the available prey in Cook Inlet and the Gulf of Alaska. This effect on discrete food sources could be short- or long-term but would not likely have population-level impacts on whales or their prey. The seasonal presence of migrant whale species such as fin, gray, and humpback whales, means the likelihood of them contacting a large spill must occur between late spring and early fall when they are present. Resident cetaceans such as beluga, killer, and minke whales, Dall’s and harbor porpoises, and Pacific white-sided dolphins could be affected by a large spill at any time; however, they only occur in small numbers within the inlet, and belugas spend most of the year in the upper inlet areas of Knik and Turnagain Arms, away from the Lease Sale Area. For these reasons, population-level impacts to these species would be unlikely.

A gas release during winter would not affect migrant whales since they would be absent from the inlet. A gas release during spring, summer, or fall could expose some cetaceans to natural gas at high concentrations. However, natural gas VOCs would disperse rapidly upon release, and it is unlikely many individuals of any species would be close enough to the gas release site to be affected. A gas release could temporarily reduce the available food for whales in a small, localized area (Section A-3.4.2).

Oil Spill Risk Analysis

BOEM identified 51 cetacean resource areas for the analysis (Ji and Smith, 2021; Table A.1-4; and Figures B-1a, B-2a–g). The OSRA acronyms are ERA Environmental Resource Area and LA Launch area.

Conditional Probabilities. Cetacean species are collectively addressed for the conditional analysis. Table A7 and Figure A6 show 33 and 23 cetacean resource areas with a ≥0.5 percent chance of contact in summer and winter respectively. Some biologically important areas for whales are not estimated to be contacted (<0.5 percent) or have a <6 percent chance of contact. This analysis focuses on those areas having a ≥6 percent chance of contact in summer (20) or winter (11) shown in Figure A6. For all LAs, there is a lower chance of contacting cetacean resource areas in the winter than in the summer when more habitat is occupied, and migrant cetaceans are present. Figure A6 shows resource areas located in western Cook Inlet coastal areas have the greatest chances of contact and resource areas between Kachemak Bay and Shelikof Strait-Kodiak Island have the second highest chances of contact.

Summer. Within 30 days a large spill has the highest chance (≥50 percent) of contacting the Cook Inlet 4- Harbor Porpoise (104) and West Cook Inlet-Beluga Critical Habitat (CH) (72). To a lesser extent, the Middle Cook Inlet-Beluga CH (71), Kachemak-Humpback Whale (75), Shelikof MM 1 (80), Barren Islands-Fin Whale (90), Cook Inlet 2-Harbor Porpoise (102), Cook Inlet 3-Harbor Porpoise (103), and Cook Inlet 5-Harbor Porpoise (105) had chances of contact ranging from ≥25–<50 percent.

Winter. Within 30 days a large spill has the highest chance of contacting (≥50 percent) the West Cook Inlet-Beluga CH (72). Other cetacean resource areas showing higher chances of contact are West Cook Inlet-Beluga CH, Shelikof MM 1, and Barren Islands-Fin Whale.

Table A7: Highest Percent Chance of a Large Oil Spill Contacting Cetacean Resources (Assuming a Large Spill Occurs)[1]

OSRA Feature Type	Highest Chance of Contact	Summer: 30 days	Winter: 30 days
ERA	≥0.5–<6	70, 73, 78, 84, 85, 86, 87, 89, 91, 92, 97, 99, 109	16, 26, 27, 70, 76, 78, 89, 91, 94, 97, 99, 109
ERA	≥6–<25	16, 76, 77, 81, 82, 83, 94, 95, 98, 101, 108	24, 25, 75, 77, 95, 98, 108
ERA	≥25–<50	71, 75, 80, 90, 102, 103, 105	71, 80, 90
ERA	≥50	72, 104	72
Names of ERAs Contacted: 16 Inner Kachemak Bay; 24 Shelikof MM 2; 25 Shelikof MM 3; 26 Shelikof MM 4; 27 Shelikof MM 5; 70 Forelands-Beluga CH; 71 Middle Cook Inlet-Beluga CH; 72 West Cook Inlet-Beluga CH; 73 NPRW Feeding Area; 74 NPRW CH; 75 Kachemak-Humpback Whale; 76 Shelikof-Humpback Whale; 77 N Kodiak-Humpback Whale; 78 E Kodiak-Humpback Whale; 80 Shelikof MM 1; 81 Shelikof MM 1a; 82 Shelikof MM 2a; 83 Shelikof MM 3a; 84 Shelikof MM 4a; 85 Shelikof MM 5a; 86 Shelikof MM 6a; 87 Shelikof MM 9; 89 Shelikof MM 11; 90 Barren Islands-Fin Whale; 91 NE Kodiak-Fin Whale; 92 Kodiak-Gray Whale Feeding; 94 Lower E Kenai-Gray Whale; 95 NE Kodiak-Gray Whale; 97 SE Kodiak-Gray Whale; 98 Shelikof-Gray Whale; 99 N Shumagin-Gray Whale; 101 Cook Inlet 1-Harbor Porpoise; 102 Cook Inlet 2-Harbor Porpoise ; 103 Cook Inlet 3-Harbor Porpoise; 104 Cook Inlet 4-Harbor Porpoise; 105 Cook Inlet 5-Harbor Porpoise; 108 Shelikof-Killer Whale.			

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all LSs with <0.5 percent chance of contact are not shown.
Source: Ji and Smith (2021).

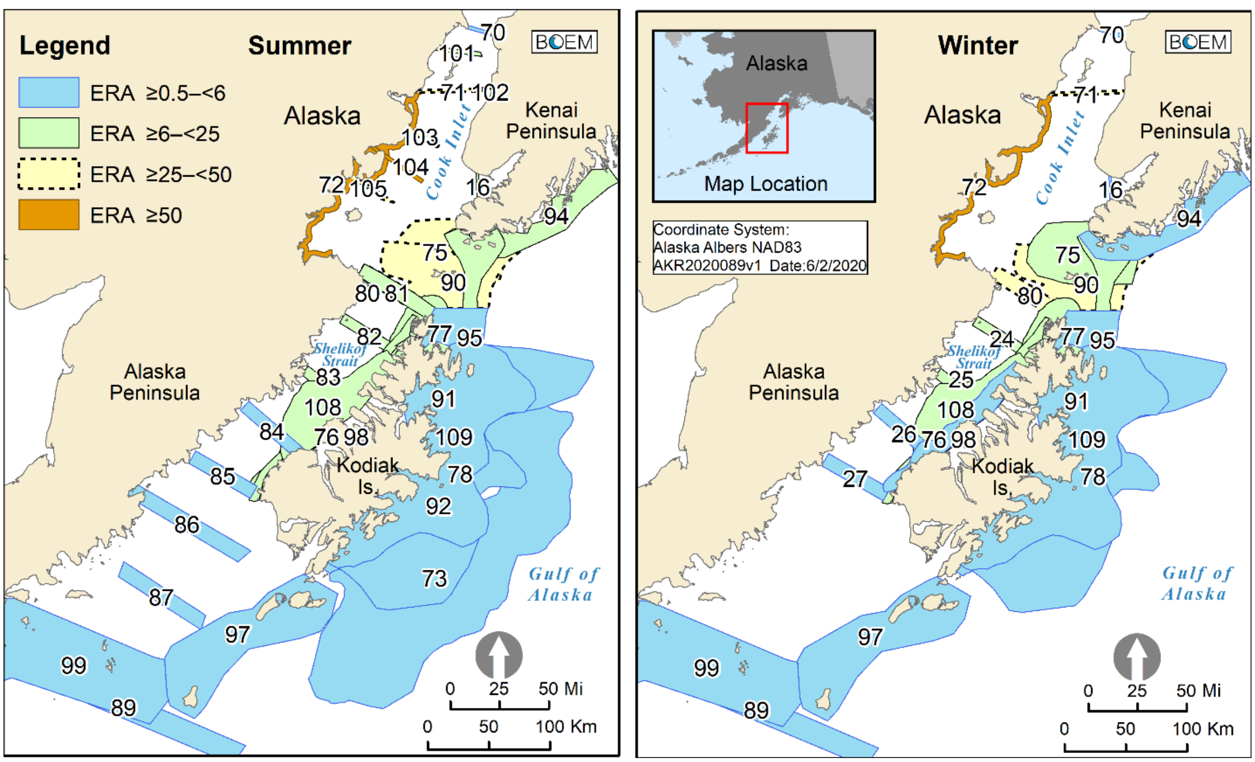


Figure A6: Location and ID number of Cetacean Resource Areas (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

Combined Probabilities. Combined probabilities for 30 of 51 cetacean resource areas are <0.5 percent and 19 are ≥1–<6 percent (Ji and Smith, 2021, Table A.2-61). The OSRA estimated the highest chance of a large spill both occurring and contacting is 11 percent within 30 days to the West Cook Inlet-Beluga CH (72) (Ji and Smith, 2021, Table A.2-61).

A-3.6.1.3 Spill Drills and Response Activities

Spill drills, including GIUEs, would result in short-term and localized displacement of cetaceans due to increased vessel activity and disturbance. Whales would be expected to resume their normal activities after the drills are complete.

Depending on the spill location, oil spill response could take some time to mobilize vessels and aircraft. The National Oceanic and Atmospheric Administration (NOAA) developed oil spill response guidelines for whales and noted that most impacts to whales from spill response activities would likely be from vessel and aircraft presence (NMFS, 2019). Cleanup activities could involve multiple marine vessels operating in the spill area for extended periods of time. As noted in the discussion of impacts associated with vessel traffic (EIS Section 4.8.2), whales may react to the approach of vessels with avoidance behavior, and potential for whale-vessel collisions could increase. Whales would likely avoid the louder noises related to a spill response, reducing the potential for them contacting oil; however, porpoises and dolphins sometimes seek out vessels in order to play. After an oil spill, helicopter and fixed-wing aircraft overflights would typically be used to track the spill and to monitor distributions of marine wildlife. Impacts to cetaceans from aircraft encounters would be transient, and animals would typically resume normal activities after aircraft leave the area.

Cleanup and response activities could result in localized, short- or long-term displacement of cetaceans and their prey from preferred habitats and disturbance through increased human interactions. Conversely, response activities would also decrease the likelihood of contact with oil by removing oil from the environment and displacing animals from oiled areas. The use of dispersants, while not immediately harmful to cetaceans, can create disruptions in food webs (Section A-3.4). While there would likely be impacts to individual animals, these activities and their potential impacts to whales, porpoises, or dolphins would not have population level effects.

A-3.6.1.4 Conclusion

Due to their small size, localized and temporary impacts, and rapid weathering, it is expected that small spills would not impact cetacean populations. Depending on the location, timing, duration, sea and climatic conditions, and spill response, a 3,800 bbl large spill would have inconsequential impacts on whale populations, with the exception of Cook Inlet belugas. A large spill contacting aggregations of Cook Inlet belugas could have permanent and adverse population-level effects due to their small number of individuals in the population. A large gas release, cleanup and response activities, and spill drills would also have inconsequential impacts on cetacean populations.

A-3.6.2 Pinnipeds

Harbor seals and Steller sea lions occur in the Proposed Lease Sale Area and could be affected by oil spills at any time of year. They occur throughout lower Cook Inlet though both use coastal haulouts, and mostly remain in shallower coastal areas. Both species feed on fishes throughout the water column. Harbor seals in the inlet belong to the Cook Inlet-Shelikof Strait stock and Steller Sea Lions belong to the Western Distinct Population Segment (DPS).

A-3.6.2.1 Small Oil Spills (<1,000 bbl)

Few individual seals or sea lions would be expected to be contacted by small spills given the spills' limited size and extent. Furthermore, seals have demonstrated an ability to eliminate small amounts of ingested crude oil from their bodies (Geraci and St. Aubin, 1990). Seals and sea lions would not likely be harmed by small spills, because spills would be cleaned up, or disperse and weather quickly, limiting the duration and severity of any exposures.

A-3.6.2.2 Large Oil Spill (≥1,000 bbl)/Gas Release

Impacts to pinnipeds from a large, 3,800 bbl spill would depend on the location, timing, and duration of the spill, sea and climatic conditions, and spill response. The conditional analysis below shows the chance of contact in summer or winter is highest for areas of western Cook Inlet, particularly in and around Kamishak Bay (Figure A6), but less likely around Kalgin Island and Kachemak Bay.

A large spill in open water would only affect a few seals or sea lions before cleanup and weathering would occur, and impacts would be temporary and mildly injurious, with no lingering impacts to individuals.

A gas release could expose some seals and sea lions to natural gas at high concentrations through inhalation, ingestion, and physical contact. However, rapid atmospheric dispersion and a short residence time of gas in the ocean would reduce the window for potential contacts with pinnipeds, and the severity of those contacts. It is unlikely more than a few individuals present near a gas release would be affected, and the impacts on harbor seals and Steller sea lions would consist of temporary prey reduction over a localized area (Section A-3.4.2). For these reasons, the impacts of a gas release on pinnipeds would be short-term, localized, and non-injurious.

Oil Spill Risk Analysis

BOEM identified 34 pinniped resources for the analysis (Ji and Smith, 2021; Table A.1-5; Figures B-2a–e, h). The OSRA acronyms are ERA Environmental Resource Area.

Conditional Probabilities.

Table A8 and Figure A7 show harbor seal and Steller sea lion resource areas with a ≥1 percent chance of contact in summer and winter. Many areas were not contacted (<0.5 percent) or have a <6 percent chance of contact. This analysis focuses on resource areas with a ≥6 percent chance of contact (Table A8). For conciseness, only areas with chances of contact within 30 days and are ≥25 percent are discussed.

Summer. Within 30 days Augustine (11), South Cook HS 1a (12), South Cook HS 1b (13), South Cook HS 1c (14), and Clam Gulch HS (17) have a ≥50 percent chance of contact. The pinniped resource areas having the next highest chances of contact were South Cook HS 1d (15) and Tuxedni HS (18), with a chance of contact ≥25–50 percent. The greatest chances of contact were to the western portions of lower Cook Inlet. Areas with lower chances of contact occurred outside of Cook Inlet, mostly around the Barren Islands and in Shelikof Strait. Spills contacting those areas could affect Steller sea lions which have rookeries there, but the chances of contacting any area outside of Cook Inlet are <25 percent, with most <6 percent.

Winter. A large oil spill occurring in winter has similar chances of contacting pinniped resource areas as described for summer except the Clam Gulch HS (17) increases to ≥50 percent chance and three resources, in northern Cook Inlet (16, 20) and central Shelikof Strait (26), are contacted slightly less.

Table A8: Highest Percent Chance of a Large Oil Spill Contacting Seal and Sea Lion Resources (Assuming a Large Spill Occurs)[1]

OSRA Feature Type	Highest Chance of Contact	Summer: 30 days	Winter: 30 days
ERA	≥0.5–<6	21, 27, 28, 29, 30, 31, 32, 37, 38, 43	16, 20, 26, 27, 28, 29, 30, 31, 37, 43
ERA	≥6–<25	16, 19, 20, 23, 24, 25, 26	19, 23, 24, 25
ERA	≥25–50	15, 18	15, 17, 18
ERA	≥50	11, 12, 13, 14, 17	11, 12, 13, 14
Names of ERAs Contacted: 11 Augustine; 12 South Cook HS 1a; 13 South Cook HS 1b; 14 South Cook HS 1c; 15 South Cook HS 1d; 16 Inner Kachemak Bay; 17 Clam Gulch HS; 18 Tuxedni HS; 19 Kalgin Island HS; 20 Redoubt Bay HS; 21 Trading Bay HS; 23 Barren Is. Pinniped; 24 Shelikof MM 2; 25 Shelikof MM 3; 26 Shelikof MM 4; 27 Shelikof MM 5; 28 Shelikof MM 6; 29 Shelikof MM 7; 30 Shelikof MM 8; 31 Kodiak Pinniped 1; 32 Kodiak Pinniped 2; 37 Port Chatham Pinniped; 38 Port Dick Pinniped; 39 Two-Arm Bay Pinniped; 43 AK Peninsula Pinniped 1			

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all resource areas with <0.5 percent chance of contact are not shown.

Source: Ji and Smith (2021).

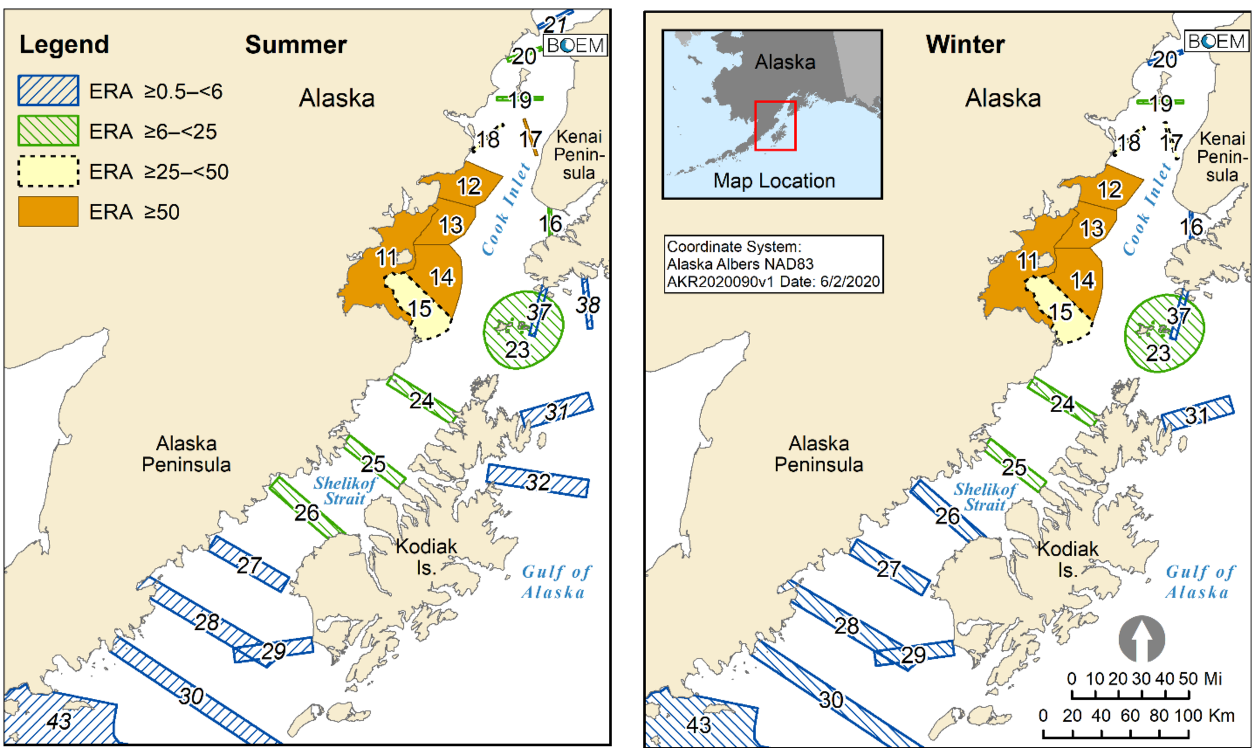


Figure A7: Location and ID number of Seal and Sea Lion Resource Areas (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

Combined Probabilities. Harbor seal resource areas Augustine (11), South Cook HS 1a (12), South Cook HS 1b (13), South Cook HS 1c (14), and Inner Kachemak Bay (16) have 6–13 percent combined probabilities. However, the remaining resource areas for harbor seals and Steller Sea lions are <6 percent with most <3 percent (Ji and Smith, 2021, Tables A.2-61).

A-3.6.2.3 Spill Drills and Response Activities

Spill drills, GIUEs, and spill response activities could disturb and displace pinnipeds from affected marine and coastal areas. Vessel and aircraft traffic, and activities such as in-situ burning, animal rescue, and the use of skimmers and booms could displace or stress individuals. Typical responses of pinnipeds to any of these disturbances would consist of leaving the local area for the duration of the disturbance.

The use of dispersants is unlikely to have any immediate direct impacts on harbor seals or Steller sea lions; however, there may be some adverse consequences from using certain types of dispersants which may affect the food web (Section A-3.4), and the long-term impacts of dispersant use may extend beyond the contaminated area to varying degrees.

Because impacts would be limited to temporary avoidance of an area for the duration of the disturbance, no injuries to pinnipeds from spill drills, GIUEs, and spill response would be expected. For spill responses, any negative short-term impacts from disturbance would be outweighed by beneficial impacts from intentionally or unintentionally deterring individual animals away from oiled areas, resulting in little or no impacts to harbor seals or Steller sea lions.

A-3.6.2.4 Conclusion

Small and large oil spills, and a large gas release would not impact pinniped populations because of the limited spatial area contacted, weathering processes, short duration of potential contact incidents, and the mostly temporary duration of impacts on individual pinnipeds, though impacts to a few individuals from a large oil spill could be lethal. Spill response and cleanup would produce disturbances displacing harbor seals and Steller sea lions from oiled areas while removing oil from the environment. Likewise, the volume of the spill would make the likelihood of contacting haulouts for either species remote, though some CH for the Western DPS of Steller Sea lions could become oiled. Overall, impacts to pinniped populations from large oil spills would be non-injurious, temporary, and non-chronic, though impacts to a few individuals could be fatal.

Sea Otters

Sea otters occur in the Cook Inlet area year-round and could be affected by oil spills during any season. The potential impacts would be greatest near the coastlines of lower Cook Inlet where sea otters aggregate, particularly in CH for the Southwestern Alaska sea otter stock.

A-3.6.2.5 Small Oil Spills (<1,000 bbl)

While a small spill could contact individual sea otters or their prey, contact remains unlikely because most small spills would cover a small area. Moreover, spills would be cleaned up quickly and cleanup activities would deter sea otters from entering the areas further reducing the likelihood of impacts.

Small spills would also be contained or weather quickly, further reducing chances of contacting a sea otter. If a small spill were to contact sea otters some could perish if their pelts became saturated with oil. Consequently, the impacts of small spills on small numbers of sea otters would be short-term, localized, and most likely inconsequential.

A-3.6.2.6 Large Oil Spill (≥1,000 bbl)/Gas Release

The extent of impact of a large oil spill to sea otters would be influenced greatly by the volume, trajectory, and timing of the spill as well as the residence time of spilled oil in the environment. (Helm et al., 2015). The likelihood of individual sea otters being contacted by spilled oil varies with individual responses to the spill, currents and tides, spill volumes, spill locations, coastal topography, and weather patterns (Geraci and St. Aubin, 1990; Garrott et al., 1993).

A large spill contacting sea otter habitat could compromise its future value to sea otters as hunting, resting, and reproduction habitat and may require a decade or more for populations to recuperate (Ballachey et al. 2014; Monson et al. 2000; Garshelis and Johnson, 2013). If a large spill were to contact a sea otter aggregation area such as feeding areas, higher numbers of fatalities could occur (DeGange et al., 1995).

A pipeline gas release would rapidly disperse into the atmosphere, so the event would not directly impact sea otters unless the gas ignites or explodes, or if they inhale hazardous concentrations of gas. Although high concentrations of natural gas could be hazardous to sea otters in the short-term, the VOCs would rapidly disperse from the release site, for this reason it is unlikely any sea otters, other than those immediately around a gas release, would be impacted.

Other impacts of a gas release would be short-term disturbances from response and possible localized prey reduction for sea otters in the area. An explosion could kill or injure nearby sea otters. For these reasons a pipeline release of gas would not impact sea otter populations. The conditional analyses show contact in summer and winter is most likely along the western coast of Cook Inlet, particularly the CH areas around Kamishak Bay and adjacent areas, including islands, and areas around Kachemak Bay. Gas releases in the Lease Area would not likely affect sea otters.

Oil Spill Risk Analysis

BOEM identified 43 sea otter resource areas for the analysis (Ji and Smith, 2021; Table A.1-6; Figures B-2a, b, e, f, h, 3a-c, and 4b). The OSRA acronyms are: ERA Environmental Resource Area; LS Land Segment; and GLS Grouped Land Segment.

Conditional Probabilities. Table A9 and Figure A8 show 23 sea otter resource areas with a ≥1 percent chance of contact in summer or winter. The areas with the greatest chance of contact occurred in western portions of lower Cook Inlet and to a lesser degree, the entrance of Kachemak Bay and Clam Gulch.

Summer. Within 30 days a large oil spill has a ≥50 percent chance of contacting Outer Kachemak Bay (46); SW Cook Inlet (47); or Kamishak Bay (48). The remaining resource areas identified for sea otters have <25 percent chances of contact.

Winter. Table A9 and Figure A8 show roughly the same patterns as discussed above for a summer spill, with the following notable differences. The chance of contact to Clam Gulch (45) increases and Outer Kachemak Bay (46) decreases to ≥25–<50 percent. The remaining resource areas identified for sea otters would have chances of contact at <25 percent, with most at <6 percent.

Table A9: Highest Percent Chance of a Large Oil Spill Contacting Sea Otter Resources (Assuming a Large Spill Occurs)[1]

OSRA Feature Type	Highest Chance of Contact	Summer: 30 days	Winter: 30 days
ERA	≥0.5–<6	50, 51, 59, 60, 65, 66	50, 57, 59, 60, 65
ERA	≥6–<25	45, 49, 64, 67, 68	49, 64, 67, 68
ERA	≥25–<50	--	45, 46
ERA	≥50	46, 47, 48	47, 48
LS	≥0.5–<6	84, 86, 87	84, 86, 87
LS	≥6–<25	35	35
GLS	≥0.5–<6	124, 152, 159	124, 152, 159
GLS	≥6–<25	141	141
Names of ERAs Contacted: 45 Clam Gulch; 46 Outer Kachemak Bay; 47 SW Cook Inlet; 48 Kamishak Bay; 49 Katmai NP; 50 Becharof NWR; 51 Alaska Peninsula NWR- N; 57 Trinity Islands; 59 Kodiak NWR-south; 60 Kodiak NWR-west; 64 Afognak-west; 65 Afognak-north; 66 Afognak-east; 67 Shuyak; 68 Kenai Fjords-west Names of LSs Contacted: 35 Chisik Island; Tuxedni Bay; 84 Malina Bay; Raspberry Island; Raspberry Strait; 86 Uganik Bay Uganik Strait; Cape Ugat; 87 Cape Kuliuk; Spiridon Bay; Uyak Bay Names of GLSs Contacted: 124 Kukak Bay; 141 Seldovia side Kachemak Bay; 152 Barren Islands; 159 Kupreanof Strait			

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all resource areas with <0.5 percent chance of contact are not shown.
-- No highest percent chance in this range.
Source: Ji and Smith (2021).

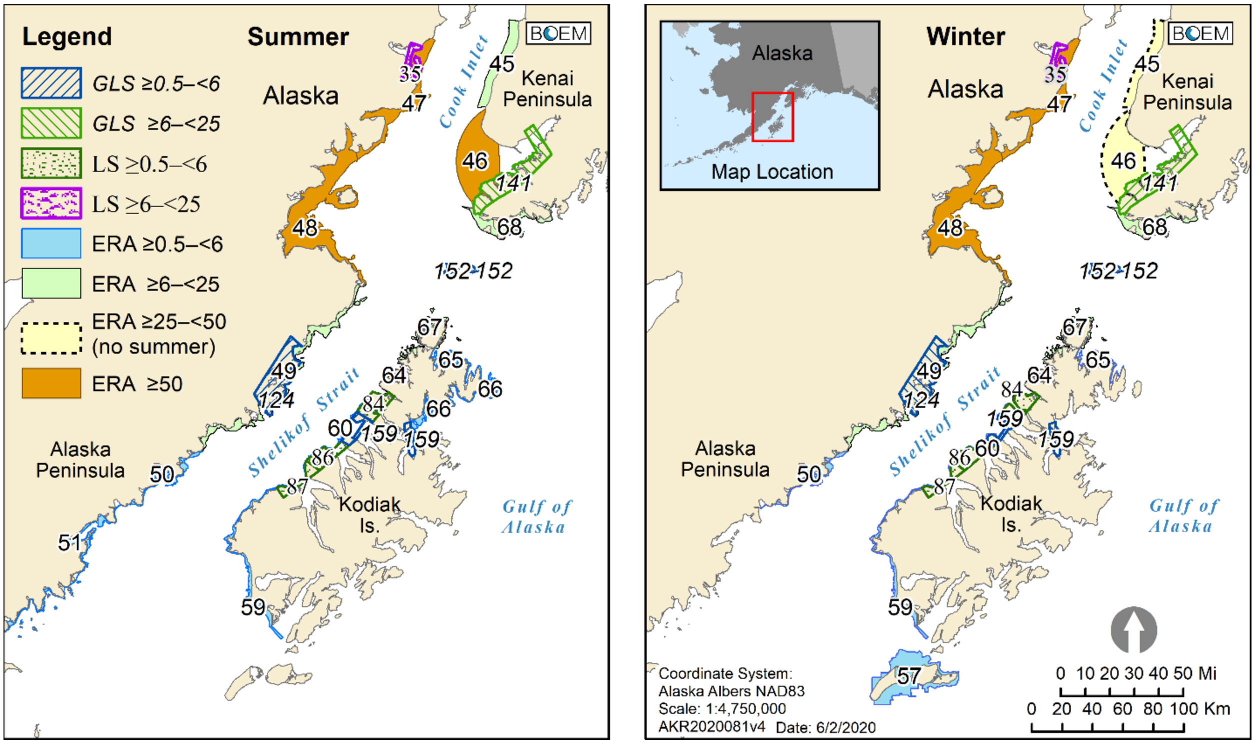


Figure A8: Location and ID number of Sea Otter Resource Areas (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

Combined Probabilities. Combined probabilities for 33 of 43 sea otter resource areas are <0.5 percent and 8 are <6 percent (Ji and Smith, 2021, Tables A.2-61). The estimated percent chance of occurrence and contact within 30 days to sea otter resource areas was greatest for SW Cook Inlet (47) (6 percent) and the Outer Kachemak Bay/IBA (46) (10 percent), which are areas adjacent to the Proposed Lease Sale Area.

A-3.6.2.7 Spill Drills and Response Activities

Spill drills, including GIUEs, and spill responses would result in short-term displacement of sea otters from habitats due to increased human interaction and disturbance. Sea otters are expected to resume normal behaviors after the activities conclude. Standard monitoring practices and approved deterrence procedures to move sea otters away from areas of activity would further limit adverse impacts. Impacts associated with response activities were analyzed in the *Biological Opinion for the Alaska Federal/State Preparedness Plan for Response to Oil & Hazardous Substance Discharges/Releases* (USFWS, 2015a).

Some sea otters may be curious and approach personnel who are in vessels. Typically, authorizations from the U.S. Fish and Wildlife Service (USFWS) include hazing as a method of keeping sea otters away from oiled areas. Oiled individuals may be captured and transported for cleaning and treatment (USFWS, 2015a; NMFS, 2019). Although deterrence would likely cause stress and disturbance among individuals, such events would be infrequent so large numbers of individuals would not be affected.

Spill drills and response activities could range from little to no impacts, to infrequent, temporary, and short-term disturbance or displacement of individual sea otters and their prey from preferred habitats.

A-3.6.2.8 Conclusion

Small spills would not impact sea otter populations, though some individuals could perish. Overall, depending on the trajectory and timing of a large spill, and the residence time of oil in the environment, a large spill could have lethal impacts to sea otters in localized areas, but small and temporary effects on either stock of sea otters. A gas release could be fatal to a small number of sea otters if their pelts became fouled with condensate; however, population-level impacts would not occur. Spill drills and response activities would not produce population-level impacts, mostly disturbing sea otters near drill and response activities.

A-3.6.3 Overall Marine Mammal Conclusion

Small oil spills, a large gas release, spill drills, and spill response are expected to have limited potential to affect marine mammal populations. Due to the relatively small size of the area affected, weathering processes in Cook Inlet, the short duration of incidents, and the remote likelihood for population-level impacts, small spills, a large gas release, spill drills, and spill response are not expected to affect marine mammal populations. Effects to marine mammals are likely to be short-term and temporary, producing temporary behavioral responses for a limited number of individuals. Large oil spills are not expected to substantively affect most marine mammal populations, though fatal effects could occur for a few individuals. Impacts to beluga whale and sea otter populations from a large oil spill would likely be inconsequential. However, beluga whales and sea otters often aggregate in key habitat areas largely designated as Critical Habitat throughout the Cook Inlet region. If a large oil spill impacts an area where beluga whales or sea otters are aggregated and they are subsequently injured, their populations could be adversely affected.

A-3.7 Terrestrial Mammals

The general effects of an oil spill on terrestrial mammals can be both immediate and long-term from physical contact, inhalation, and/or ingestion of contaminants (Osweiler 2018; AMAP 2010; BOEM, 2020, Figure 4-3). Impacts can range from temporary injuries such as skin irritation and damage, to long-term disease and organ failure; for example, cancer, liver disease, and compromised immune or reproductive systems (Osweiler, 2018). Mortality may occur due to just one, or a combination of exposures, but is most commonly associated with hypothermia and inhalation. Spills may also affect vertebrate animals through habitat degradation and prey or forage contamination by toxic compounds, including PAHs (Burns et al., 2014). Potential effects of an oil spill on terrestrial mammals may include:

- Effects of oil contact: irritation, inflammation, or necrosis of skin; chemical burns of skin, eyes, or mucous membranes; absorption of toxic compounds through skin (Osweiler, 2018); and hypothermia resulting from compromised fur (Garshelis and Estes, 1997). Short- and long-term respiratory effects may include inflammation, pulmonary emphysema, or infection (MDNR, 2019).
- Effects of oil ingestion: gastrointestinal inflammation; ulcers; bleeding; liver, kidney, and brain tissue damage; cancer/tumor development; compromised immune/reproductive systems; and altered respiration and heart rate (MDNR, 2019; AMAP, 2010; Burns et al., 2014; Frisch, Øritsland, and Krog, 1974).
- Effects of oil spills on habitat include physical and chemical degradation (Burns et al., 2014).

Additional discussion of the general impacts of oil and gas on terrestrial mammals is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.7).

A-3.7.1 Small Oil Spills (<1,000 bbl)

Small spills from an onshore pipeline or machinery leaks are more likely to contact and affect terrestrial mammals or their habitat than offshore small spills, which are highly likely to disperse and weather prior to reaching land. Winter spills would be unlikely to contact terrestrial mammal habitat because ice and snow slow the spread of oil and provide a barrier to oiling of habitat, thus allowing for more effective spill cleanup.

During summer, small spill size (<1,000 bbl), and low densities of highly mobile terrestrial mammals would be expected to limit impacts, and it is likely that few individuals would be contacted. A small summer pipeline spill would be expected to contact a relatively small area of terrestrial mammal habitat, and individuals would readily move away from the affected area. This situation would provide little opportunity for oiling terrestrial mammals. Spills could remain near the soil surface and terrestrial mammals could contact oil until spill cleanup and remediation.

During winter, few terrestrial mammals are present/active, further decreasing the likelihood of contact with a small spill. Impacts from small spills in summer and winter would be limited to avoidance of the area because of the presence and strong odor of hydrocarbons, and the disturbance created by spill cleanup.

A-3.7.2 Large Oil Spill (≥1,000 bbl)/Gas Release

Impacts to terrestrial mammals from oil exposure could include any one or a combination of those impacts summarized above. A large, 3,800 bbl onshore pipeline oil spill could have a large affected area if the oil was discharged under pressure and the spill occurred in summer (Conn et al., 2001). As with small spills, a large winter spill would be constrained by snow and ice, allowing for more effective cleanup. However, a large spill in any season has a greater potential to oil terrestrial mammals, and temporarily or permanently remove habitat, depending on the use and success of cleanup procedures.

Brown bears utilize tidal flats and marshes for spring foraging to recover from hibernation, and salmon runs in area rivers are also heavily used during summer and fall. Because they use these habitats, brown bears could be exposed to oil from a large spill and experience the general impacts described above. Impacts would, however, be spatially limited due to large bear home ranges and the limited extent of oiled shoreline (Table A2). No more than a few bears would potentially be affected.

Overall, the potential impacts of a large spill on terrestrial mammals would be lessened by weathering processes that reduce the quantities and toxicity of oil present in the environment, and by spill cleanup and response activities that disturb or displace terrestrial mammals. These factors decrease the likelihood that terrestrial mammals would come into contact with oil and therefore decrease potential impacts.

A large gas release has a lower potential for impacts on terrestrial mammals because it would rapidly disperse into the atmosphere and be transported away from the release site by winds. Concentrations of methane would not be sufficient to asphyxiate terrestrial mammals in the vicinity of the release. If ignition and/or explosion occurred in association with a gas release, terrestrial mammals could be injured or killed in close proximity to the release site. The loss of habitat due to burning would vary depending on season, weather, and range condition (wet/dry status of vegetation) and whether or not any suppression efforts occurred. Overall, mortality would be expected to be low due to low densities of terrestrial mammals in proximity to onshore pipelines for most of the year, and the unlikely event of a gas release and subsequent fire and explosion.

A-3.7.2.1 Oil Spill Risk Analysis

BOEM identified 15 terrestrial mammal resource areas for the analysis (Ji and Smith, 2021; Table A.1-7; and Figures B4a–b). The OSRA acronym is GLS Grouped Land Segment.

Conditional Probabilities. Table A10 and Figure A9 show 9 resource areas with a ≥0.5 percent chance of contact within summer or winter. Figure A9 shows 5 resources with a ≥6 percent chance of contact in summer or winter. Six biologically important areas for terrestrial mammals are not estimated to be contacted (<0.5 percent). This analysis focuses on the five resource areas with a ≥6 percent chance of contact.

Summer. The chances of contacting resource areas important to terrestrial mammals are highest for Redoubt Bay Brown Bears (129), West Kenai Brown Bears (136), and West Kenai Black Bears (140). Each resource area is generally contacted the most from a large spill directly adjacent to their geographic location. Redoubt Bay (129) 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 located within Redoubt Bay (129) (ADNR, 2009), 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 (ADF&G, 2020). Portions of West Kenai Brown Bears (136) serve as moose (ADNR, 2009) and caribou (ADF&G, 2003) calving grounds during the spring, providing brown bears with additional food sources. Area rivers support summer and fall salmon runs, which brown bears rely on heavily. Tidal flats and marshes in area West Kenai Black Bears (140) 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, 2011), these factors make this an important foraging area for black bears.

Winter. The patterns of winter contact are generally similar to summer with lower chances of contact to areas that are not utilized by the resource for much of the winter (hibernation) and contact with a few additional resource areas. Chances of contacting terrestrial mammal resource areas are highest for GLSs Afognak, Raspberry Winter Elk (155) and Afognak Black Tail Deer (157). The beaches in these areas provide important wintering areas for black tailed deer and elk. Woody browse provides the majority of the winter diet for both species (ADF&G, 2020; AKNHP, 2011; Wallmo and Schoen, 1979), and black tailed deer also take advantage of accumulations of kelp washed ashore (Veeramachaneni et al., 2006).

Table A10: Highest Percent Chance of a Large Oil Spill Contacting Terrestrial Mammal Resources (Assuming a Large Spill Occurs)[1]

OSRA Feature Type	Highest Percent Chance Contact	Summer: 30 days	Winter: 30 days
GLS	≥0.5–<6	125, 137	125, 129,131, 136, 137, 140,160
GLS	≥6–<25	129, 136, 140	155, 157
Names of GLSs Contacted: 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; 155 Afognak, Raspberry Winter Elk; 157 Afognak Black Tail Deer;160 Kodiak Black Tail Deer			

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all GLSs with <0.5 percent chance of contact are not shown.
Source: Ji and Smith (2021).

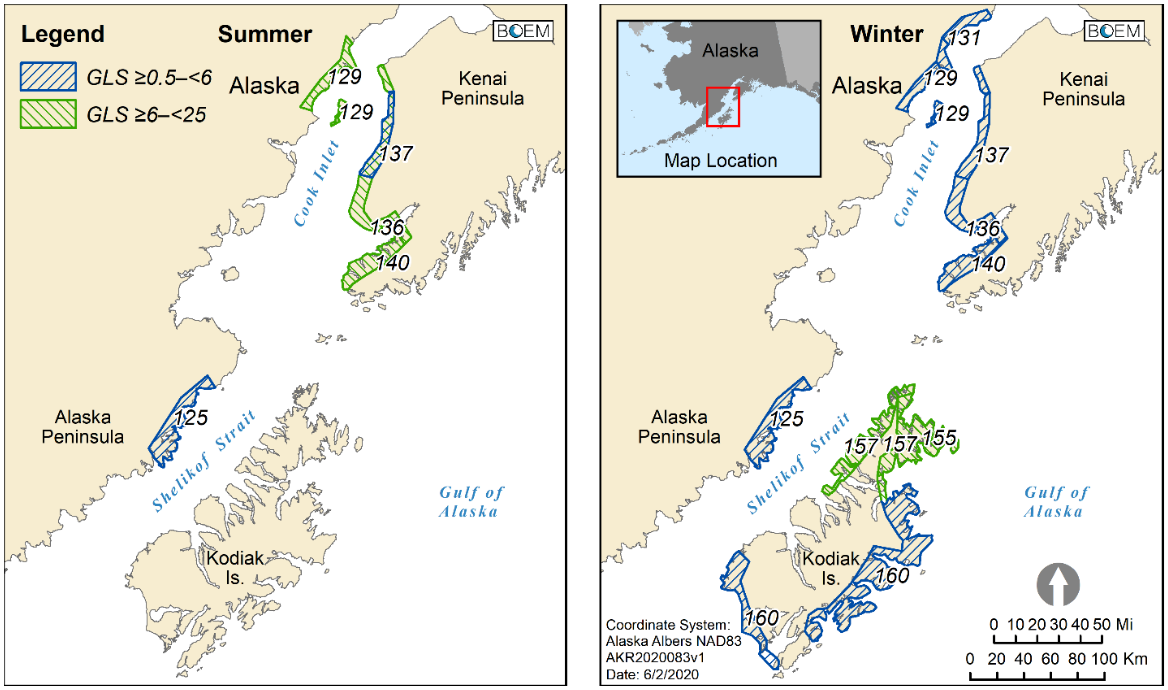


Figure A9: Location and ID number of Terrestrial Mammal Resource Areas (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

Combined Probabilities. There is a 1 percent chance of a large spill occurring and contacting Redout Bay Brown Bears (129), West Kenai Brown Bears (136), West Kenai Black Bears (140) and Afognak& Raspberry Winter Elk (155) within 30 days. All other combined probabilities for terrestrial mammal resource areas were <0.5 percent within 30 days (Ji and Smith, 2021, Table A.2-63).

A-3.7.3 Spill Drills and Response Activities

The presence of humans, vessels, equipment, vehicles, and aircraft during spill drills (including GIUEs), or spill response could displace some terrestrial mammals. Aircraft operating below 1,000 feet above ground level can cause panic and injurious escape reactions among most terrestrial mammals. Vessels usually produce much less of a disturbance unless they are operating in coastal or riverine areas with terrestrial mammals nearby.

Activities such as in-situ burning and animal rescue would most likely displace some animals, and bears could be disturbed while feeding on carcasses. These disturbances could lead to bear-human conflicts, particularly during shoreline cleanup. Although beach cleaning may be performed with greater efficiency using newer technologies (Painter et al., 2011), spill response activities on shorelines may still impact terrestrial mammals. In general, broken ice spill response would have limited impacts on brown bears due to their habitat use and other factors (described above in Section A-3.7.2).

The overall impacts of spill drills and response activities on terrestrial mammals would vary depending on the area disturbed, extent of coastal area contacted by spilled materials, and the scale and effectiveness of the spill response. Mammals subject to other stressors, such as moose displacement from coastal wetland habitat, may be slightly more susceptible to disturbance impacts from these activities. Spill drills and response activities have the potential to discourage access to activity areas, which for spill response would reduce some of the more direct impacts from oil exposure. Overall, the beneficial impacts from spill drills and response activities, including GIUEs, would outweigh any negative impacts on terrestrial mammals resulting primarily from disturbance and temporary displacement.

A-3.7.4 Conclusion

Small spills, a large spill, and a gas release would have no more than minor impacts to terrestrial mammals. This is due to the limited number of resource areas that are estimated to be contacted by an offshore spill; long distances between spill sites and important terrestrial mammal habitats; weathering processes that reduce oil quantity and toxicity; and terrestrial mammal scarcity during winter.

Spill response activities would reduce the likelihood that terrestrial mammals would contact spill materials, and the activities would discourage terrestrial mammals from entering the affected area. Spill drills are generally brief, lasting one to several days, and involve human activity that would temporarily discourage terrestrial mammals from entering or remaining in an affected area. Because of the brief duration of spill drills and low level of disturbance, the impacts of spill response and spill drill activities on terrestrial mammals would be negligible.

Overall, due to a low potential for contacting spill materials, the nature of human activity associated with spills, and the low level of potential behavioral responses, the impacts of small spills, one large spill, a gas release, spill drills, and spill response on terrestrial mammals would be expected to be no more than minor.

A-3.8 Recreation, Tourism, and Sport Fishing

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 adjacent to or 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. Impacts to sport fishing would likely be limited to work occurring during summer months, which is the primary sport fishing season. 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. Potential effects of an oil spill on recreation, tourism, and sport fishing may include:

- Recreation and tourism industry incur losses caused by direct damage in the spill-affected area(s) (Cirer-Costa, 2015; Eastern Research Group, 2014; McDowell Group, 1990; Ritchie et al., 2013).
- Altered use of recreational lands or waters and reducing the scenic quality of the recreational experiences (Hausman et al., 1995).
- Changed scenery, behavior or wildlife, or patterns of visitor use or visitors' experiences in the natural setting.
- Limited ability of sport halibut and salmon fishers to depart from oiled locations. Sport fishing charter operators could lose business (Herrmann et al.,2001).

A-3.8.1 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 have long-lasting or widespread effects on recreation and tourism. 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. Small spills would result in little or no impact and thus have negligible effects on recreation and tourism.

Small spills would predominantly occur within the confines of or adjacent to the offshore. 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.

A-3.8.2 Large Oil Spills (≥1,000 bbl)/Gas Release

In contrast to small spills, a large, 3,800 bbl 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 3 days and would be unlikely to severely affect recreation, tourism, and sport fishing. Large spills of crude oil will persist longer in the environment and could result in long-lasting and widespread impacts to recreation, tourism, and sport fishing.

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. Oil that reaches the shorelines of recreational areas would have the greatest potential to adversely affect recreation and tourism. 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 visually 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.

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 or contamination, 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 timing of the large oil spill.

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. 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. 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.

An accidental release of natural gas into the environment would be expected to rise and disperse and is unlikely to affect recreation, tourism, or sport fishing. A single day release 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. The impacts of a gas blowout and resulting explosion or fire are considered minor.

A-3.8.2.1 Oil Spill Risk Analysis

BOEM identified 28 areas of special concern for the analysis (Ji and Smith, 2021; Table A.1-10; and Figures B3c and B4a–b).

Conditional Probabilities.

Table A11 and Figure A10 show 21 resources with a ≥1 percent chance of contact and 11 resources with a ≥6 percent chance of contact in summer or winter. Seven important areas for recreation, tourism, and sport fishing are not estimated to be contacted (<0.5 percent) and 10 have a <6 percent chance of contact from any location. This analysis focuses on the 11 resource areas with a ≥6 percent chance of contact. The OSRA acronyms are: LS Land Segment; and GLS Grouped Land Segment.

Summer. The chances of contacting resource areas important to recreation, tourism and sportfishing is highest (≥50 percent) for the shorelines in the Alaska Maritime National Wildlife Refuge (NWR) (127) in western Cook Inlet. Shorelines of Tuxedni State Game Refuge (35), Katmai National Park (123), Lake Clark National Park & Preserve (128), Alaska State Management Areas (126, 135, 138, 153), Alaska Maritime NWR (142, 154) and Kodiak NWR (156) are contacted ≥6 percent. These areas provide important outdoor recreation and tourism opportunities for wilderness camping and backpacking, hiking, hunting, wildlife viewing, sport fishing, and exploring. Tuxedni Bay (35), which is located within the Alaska Maritime NWR (127), is the home of seabirds, bald eagles, peregrine falcons, and other birdwatching opportunities. Katmai National Park (123) is a wilderness park that attracts people from all over the world to view brown bears and enjoy world-class fishing.

Winter. The patterns of contact are similar to summer except the highest chance of contact is to the shorelines in the Alaska Maritime NWR (127) and Lake Clark National Park & Preserve (128).

Table A11: Highest Percent Chance of a Large Oil Spill Contacting Areas of Special Concern (Assuming a Large Spill Occurs)[1]

OSRA Feature Type	Highest Percent Chance	Summer: 30 days	Winter: 30 days
LS	≥0.5–<6	38	38
LS	≥6–<25	35	35
GLS	≥0.5–<6	113, 114, 122, 130, 139, 143, 158, 164	114, 122, 130, 139, 143, 158, 161, 164
GLS	≥6–<25	123, 126, 135, 138, 142, 153, 154, 156	123, 126, 135, 138, 142, 153, 154, 156
GLS	≥25–<50	128	--
GLS	≥50	127	127, 128
Names of LSs Contacted: 35 Tuxedni State Game Refuge; 38 Kalgin Island Critical Habitat Names of GLSs Contacted: 113 Alaska Peninsula NWR; 114 AMNWR SW Shelikof/GOA; 122 Becharof NWR; 123 Katmai National Park; 126 McNeil River State Game Sanctuary & Refuge; 127 AMNWR W Cook Inlet ; 128 Lake Clark National Park & Preserve; 135 Kenai AK State Rec Mgmt Areas; 138 Clam Gulch Critical Habitat 139; Kachemak Bay State Park and Wilderness Park Kachemak Bay State Critical Habitat Area 142; AMNWR E Cook Inlet 143; AMNWR W Outer Kenai/GOA 153; Shuyak Island State Park 154; AMNWR Afognak and Shuyak Islands 156; Kodiak National Wildlife Refuge 158; AMNWR W Kodiak/Shelikof 164; Afognak Island State Park			

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all resource areas with <0.5 percent chance of contact are not shown.
-- No highest percent chance in this range.
Source: Ji and Smith (2021).

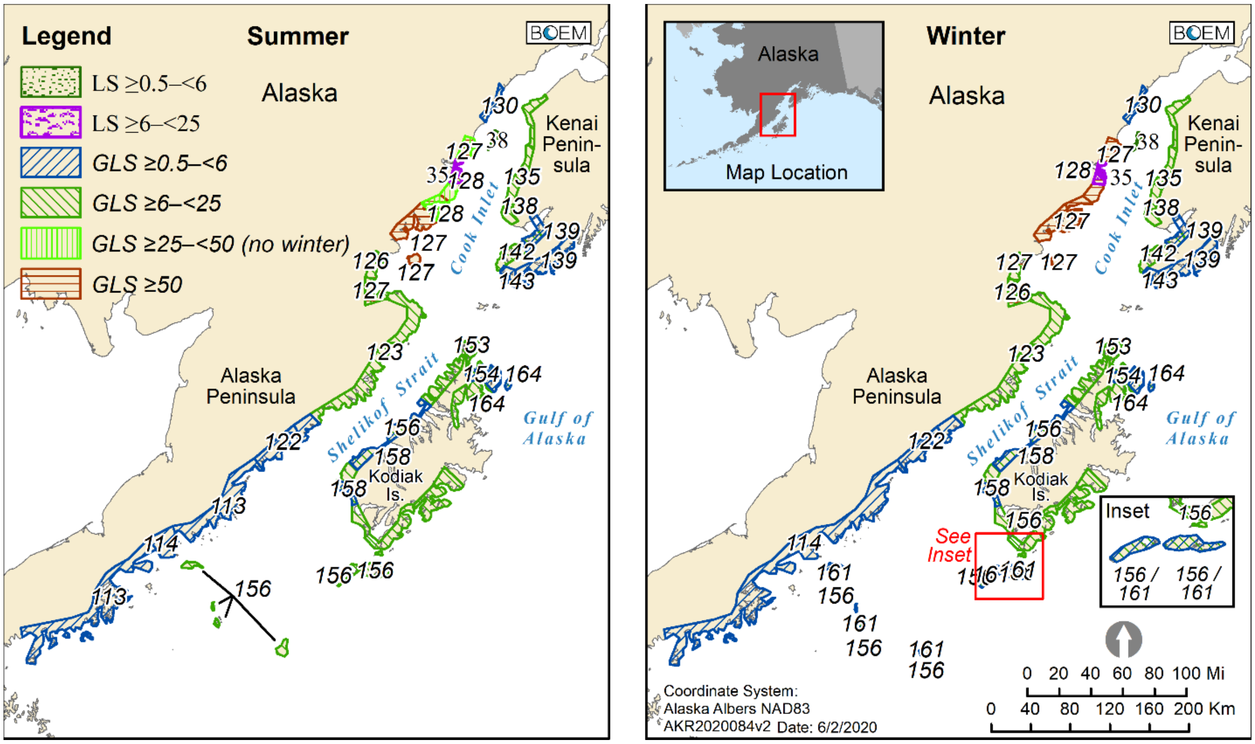


Figure A10: Location and ID number of Areas of Special Concern (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

__Combined Probabilities.__ Except for Alaska Maritime NWR (127) and Lake Clark National Park & Preserve (128), all combined probabilities for recreation, tourism and sportfishing resource areas were ≤2 percent within 30 days (Ji and Smith, 2021, Tables A.2-63). There is a 10 percent and 7 percent chance of a large spill occurring and contacting Alaska Maritime NWR (127) and Lake Clark National Park & Preserve (128), respectively, within 30 days.

A-3.8.3 Spill Drills and Response Activities

Spill drills, including GIUEs, are infrequent, short-term, and use existing equipment. If spill drills were carefully sited away from recreation use areas, they would have little to no adverse impacts to recreation and tourism.

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, tourism, and sport fishing 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 marine boating, sport fishing, and waterborne wildlife viewing are expected to be directly affected when the spill area 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 number 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.

A-3.8.4 Conclusion

Impacts to recreation and tourism would be negligible for small spills and moderate with the addition of a large oil spill. A large gas release could have minor impacts to recreation and tourism. Spill drills would have negligible impacts to recreation and tourism. Spill response and cleanup activities could have minor to moderate impacts to recreation and tourism.

Impacts to sport fishing could be minor for small spills and moderate with the addition of a large oil spill. A large gas release could have minor impacts to sport fishing activities. Spill drills would have negligible impacts to sport fishing. Spill response and cleanup would have minor to moderate impacts to sport fishing activities.

A-3.9 Sociocultural Systems

Oil spills cause psychological, social, public health, economic, and cultural impacts in society. The sociocultural system includes social organization, cultural identity, and local institutions. Impacts from an oil spill on the sociocultural system of local communities could come from disruption of subsistence through oiling of habitats and subsistence resources; spill response and cleanup activities, including changes in population, employment, and income; and social and psychological stress due to fears of potential contamination of resources (Palinkas et al., 1993). An oil spill or gas release would likely have impacts on the sociocultural system of communities in Cook Inlet and the surrounding region, with the level of consequences depending on the size, timing, location, movement, and type of product(s) spilled. Impacts could include:

- Increased social stress in communities, including loss of credibility and trust in authorities, frustration and anger, breakdown in family ties, and a weakening of community well-being (Chang et al., 2014; Impact Assessment, 1990; Lord et al., 2012, 1–23; Palinkas, 2012, 203–222; Webler and F. Lord, 2010, 723–738).
- Social and psychological distress over potential losses of cultural values and identity (Palinkas et al., 1993; Webler and Lord, 2010).
- Increased demand on the health and social services available in communities (Chang et al., 2014; Goldstein et al., 2011; Impact Assessment, Inc., 1990; Palinkas et al., 1993; Rodin et al., 1992).
- Higher rates of substance abuse, crime, domestic violence, and mental illnesses (Chang et al., 2014; Goldstein et al., 2011; Impact Assessment, Inc., 1990).
- Disruption of economy and interruption of way of life, along with decreased emphasis on subsistence as a livelihood and increased emphasis on earning wages, particularly through participation by local individuals in spill response and cleanup employment (Lord et al., 2012; Palinkas, 2012; Palinkas et al., 1993; Webler and Lord, 2010).

A-3.9.1 Small Oil Spills (<1,000 bbl)

Potential impacts from small spills of all kinds are not likely to cause disruptions to sociocultural systems except as discussed in Section A-3.10 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 and would be unlikely to affect sociocultural systems. Small spills of crude oil would persist longer in the environment and could result in more impacts than spills of refined products but are expected to be short-term and localized. Effects on cultural values could occur if oil spills alter subsistence harvest patterns. In subsistence-oriented communities, traditional emphasis is on kinship, community, cultural continuity, cooperation, and sharing. There could be little to no or short-term and localized impacts to subsistence harvest patterns from small spills, and levels of sociocultural impacts in subsistence communities would be the same.

A-3.9.2 Large Oil Spill (≥1,000 bbl)/Gas Release

A 3,800 bbl, large oil spill event would likely have effects on the sociocultural systems of communities in the Proposed Lease Sale region with the level of consequences depending on the 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, affecting the people whose livelihood is connected to salmon. Kinship relations and commercial fishing crew organization would change to respond to diminished or prohibited fish harvests (Section A-3.13). The cultural values placed on cooperation in fish harvesting, processing, sharing, and distribution could be impacted for one or more fishing seasons.

A large spill has potential to result in long-term and widespread, and possibly severe, impacts to subsistence activities and harvest patterns (Section A-3.10). Disruptions to subsistence harvest patterns from a large spill can cause social stress and anxiety from reduction or loss of traditional practices, cultural well-being, and identity. Interruption of subsistence for one or more seasons would impact sociocultural systems by impeding distribution of harvested resources within and between communities. People who rely on receiving subsistence foods to maintain their cultural values and identities would be impacted. This is especially the case for community members who are not able to hunt and fish for themselves (e.g., elders). Cultural identity would also be impacted from decreases in harvest, processing, and teaching youth the subsistence way of life. In addition, the sociocultural systems of coastal communities could be impacted by social and psychological stress due to potential contamination of subsistence food resources (Impact Assessment, Inc., 2011b; Palinkas et al., 1993).

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.

Impacts from a large spill of crude oil could be long-lasting and widespread, and possibly severe, depending on the spill location relative to the resources impacted and the duration and extent of disruption to subsistence activities and social organization. Impacts on the smaller subsistence-oriented communities in the region would likely be a greater disruptor to sociocultural systems than would be felt in larger, more heterogeneous communities less dependent on subsistence harvests. Impacts from a large spill would have a severe effect on sociocultural systems if subsistence harvesting or commercial fishing were disrupted for one or more seasons (Sections A-3.10 and A-3.13).

An offshore gas release over one day would be localized and of short duration with rapid dissipation. Implementation of safety exclusion zones would make it unlikely that subsistence or commercial fishermen would approach close enough to an offshore development to be injured from a potential blowout and gas release. Temporary and localized impacts are possible in the event of a large release of natural gas from an onshore pipeline, especially in the unlikely event of ignition near a community or near active subsistence harvesters. Impacts to the sociocultural system from a large gas release lasting one day are expected to be short-term and localized. Potential impacts to the sociocultural system from a large gas release could be avoided by siting pipelines to come ashore far from communities.

A-3.9.3 Spill Drills and Response Activities

Spill drills, including GIUEs, are infrequent, usually last less than 8 hours, and normally use existing equipment. If oil spill cleanup and response drills were carefully sited away from small communities and subsistence use areas, they would have little to no adverse impacts to sociocultural systems in those communities. Spill drills based out of existing industrial support areas in larger towns or cities would not likely be disruptive to sociocultural systems and would have little to no impact.

Effects to social and institutional organizations can occur due to local employment in spill response and cleanup activities. Cleanup employment of residents could place stresses on local village and town infrastructures by drawing local workers away from community service jobs (Palinkas et al., 1993). Other social impacts, which have been documented for VLOS-size spills but are informative for a large spill, include increased demands on community service providers, increased crime rates, labor shortages, disruption of local government activities, and social conflicts between local residents and outsiders coming to town to work on spill cleanup jobs (Palinkas et al., 1993; Webler and Lord, 2010). Over a longer duration (one or more seasons) and more widespread area, large spill cleanup activities could cause social relations and community cohesion to deteriorate in impacted communities (Palinkas et al., 1993; Palinkas, 2012). The level of impacts would depend on where cleanup activities occur in relation to communities and how long cleanup efforts last. For a 3,800-bbl spill, the impacts on local sociocultural systems would depend on the extent and duration of cleanup activities and how many residents were employed in cleanup work (Section A-3.12). Impacts would most likely be short-term and localized due to the temporary nature of initial response and cleanup jobs.

Because subsistence harvest, processing, and sharing are key supporting elements of sociocultural systems in many rural coastal communities, effects on subsistence activities and harvest patterns (Section A-3.10), would impact sociocultural systems. Short-term and localized or long-lasting and widespread effects on subsistence and sociocultural systems could occur if clean-up operations include sections of the beach or intertidal zones, or if contamination from chemicals used in cleanup generate avoidance of subsistence resources. Overall, impacts to sociocultural systems from spill response and cleanup activities are expected to be short-term and localized, to long-term and widespread, depending on the extent and location of the spill and to what extent subsistence harvest patterns are disrupted.

A-3.9.4 Conclusion

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, commercial fishing, and social organization. A large gas release over one day would be expected to have minor impacts to sociocultural systems. Spill drills would have negligible impacts to sociocultural systems, and spill response and cleanup activities could have minor to moderate impacts to sociocultural systems.

A-3.10 Subsistence Activities and Harvest Patterns

Impacts of oil spills on subsistence activities and harvest patterns could occur through changes in the availability, quality, and use of subsistence resources. Impacts would result from contact of crude oil with shorelines and fish and wildlife, and potential contamination of subsistence foods. Subsistence harvesters could purposively avoid affected subsistence areas and reduce their harvests of a particular subsistence food resource due to potential contamination (Fall et al., 2006; Impact Assessment, Inc., 2011a). Important subsistence resources could become unavailable or undesirable for one or more seasons, resulting in substantial and sustained food insecurity (Suprenand et al., 2018). Impacts could include:

- Direct mortality of targeted subsistence resources or their prey, displacement of subsistence resources, or reduced numbers of species used for subsistence purposes (Fall et al., 2006; Picou and Martin, 2007).
- Displacement of people from traditional harvest areas and/or increased competition for subsistence resources (Impact Assessment, Inc., 2011a).
- Contaminated resources unfit for human consumption or undesirability of subsistence resources as foods and avoidance of oiled resources and areas (Impact Assessment, Inc., 2011b).

- Reduced consumption of subsistence foods and other products, food insecurity, and loss of or reductions in traditional subsistence practices (Impact Assessment, Inc., 2011b; Suprenand et al., 2018).

A-3.10.1 Small Oil Spills (<1,000 bbl)

A range of impacts could occur for subsistence fishing and hunting. Impacts would be related to contaminated resources unfit for human consumption, undesirability of subsistence foods, and avoidance of resources and harvest areas affected by small spills. Most small spills would evaporate or disperse within hours to one day and would result in little to no impact on subsistence activities and harvest patterns. Small refined spills that occur offshore would float on the water surface and would disperse and weather rapidly. Small spills of crude oil would persist longer in the environment and could result in more adverse impacts than spills of refined products. Onshore spills of crude oil or refined products would be contained to localized areas and would mostly evaporate or be cleaned up quickly. Overall, there would most likely be little or no impacts to terrestrial mammal hunting from small spills because hunters would be able to pursue large game at areas outside those contacted by spills. Small spills that contact fishing, marine invertebrate gathering locations, or marine mammal or waterfowl hunting areas at shorelines or river mouths would have localized and mostly short-term impacts on subsistence activities in those areas. Longer-term impacts are possible at locations of chronic spills or where spills result in avoidance of the area by subsistence harvesters. For example, 24 percent of a small crude spill is estimated to remain after 30 days in the summer (Table A1), which would result in up to 30 bbl, or 1,260 gallons of oil remaining in the environment. If this occurred in a subsistence use area, harvesters would likely avoid the affected area while the oil remained and potentially for a longer period such as the remainder of the harvest season and potentially longer. This impact would be localized, and it is anticipated harvesters could access other locations for targeted resources. Because small spills in shoreline areas or at river mouths would not spread over large areas, impacts would remain localized to individual harvest locations. Spills that occur farther offshore would have little to no, to short-term and localized impacts on subsistence fishing, depending on their size and type, but would not make salmon or other fish unavailable to harvesters.

A-3.10.2 Large Oil Spill (≥1,000 bbl)/Gas Release

Potential impacts to subsistence harvest patterns from a large, 3,800 bbl oil spill include direct mortality of targeted subsistence resources or their prey, displacement of subsistence resources making them unavailable or more difficult to access for subsistence harvesters, and contamination of subsistence use areas and subsistence resources. Traditional harvest locations may have resources deflected due to oiling of the environment, or resources may not be available in adequate quantities to satisfy traditional harvest patterns.

A large oil spill could affect the availability of subsistence resources through impacts on the abundance and distribution of subsistence species. Long-lasting and widespread impacts from a large spill may occur for marine invertebrates, fish, and most bird populations (Sections A-3.4 and A-3.5), and these impacts could affect the availability of resources to subsistence harvesters. Most marine mammals harvested for subsistence in the Cook Inlet region are not expected to experience population-level impacts from a large spill, except for beluga whales (for which the subsistence harvest is currently closed) (Section A-3.6).

A large spill that reaches nearshore and shoreline areas could impact subsistence harvest of multiple resources. Resource harvest locations for communities overlap to a large degree. For example, a community may harvest several types of resources from the same area, so a spill contacting that area would affect the community's harvest of several resources. Community harvest locations for Seldovia, Nanwalek, and Port Graham in the Kachemak Bay area overlap to varying degrees for salmon, non-salmon fish, marine mammals, marine invertebrates, birds and eggs, and some terrestrial mammals (Jones, B. and Kostick, M. 2016). Likewise, Tyonek's harvest locations for various resources overlap on the western side of Cook Inlet (Jones et al. 2015). Oil contact to a community's harvest area could disrupt subsistence activities for multiple resources and make those resources unavailable or undesirable for use for a substantial portion of a subsistence season. A summer spill would have a greater chance of contact to harvest areas for several communities and would also coincide with the harvest season for many resources. In addition, some communities share harvest areas, so a spill contacting one area could impact harvest for several communities. For example, for the communities of Seldovia, Nanwalek, and Port Graham, nearshore waters as well as bays and river mouths in southern Kachemak Bay provide harvest locations for many resources (Jones, B. and Kostick, M. 2016). Residents of other Kenai Peninsula communities also harvest resources in the Kachemak Bay area, and some residents harvest fish or shellfish on the western side of Cook Inlet in or near Tyonek's harvest areas. Similarly, communities on parts of Kodiak Island share general harvest areas as do several communities on the upper Alaska Peninsula (BOEM 2016; Morris, 1987). BOEM estimates a large spill would affect about 26–35 km of shoreline (Table A2), which could affect a substantial portion of subsistence use areas for communities. A large oil spill that contacts communities' harvest areas, would have widespread, long-lasting, and possibly severe impacts.

Contamination of resources, and the concern about tainted subsistence foods may (1) affect harvesters' decisions about the level of effort placed into harvesting resources, (2) limit people's consumption of subsistence products, and (3) cause people to completely stop eating traditional subsistence resources for varying lengths of time following a spill event. Avoidance of subsistence resources potentially impacted by an oil spill was noted following the *Selendang Ayu* spill near Unalaska in 2004. Although state-sponsored subsistence foods testing revealed no significant threat from hydrocarbons a couple years after the spill, some residents continued to express uncertainty about the safety of foods from the affected area (Impact Assessment, Inc., 2011b). Additionally, studies conducted after the 1989 EVOS provide insight into potential effects of oil spills on use of subsistence resources. While the EVOS was a VLOS event and was many times larger than the spill size assumed for this analysis (approximately 240,000 bbl vs. 3,800 bbl), the impacts documented after the EVOS are informative of the types of impacts that could occur from a large spill. A study conducted by the Alaska Department of Fish and Game, Division of Subsistence in 2003 and 2004 found approximately half of the households surveyed reported lower total subsistence uses than before the EVOS, and 39 percent blamed spill effects for continuing lower uses of at least one resource (Fall et al., 2006). Concerns were identified in eight study communities; these were related to paralytic shellfish poisoning, which was linked to the effects of the EVOS, and inhibited marine invertebrate harvesting. Overall, 72 percent of respondents said that the traditional way of life had not recovered from the spill. The extent of impacts would be considerably less for a 3,800-bbl spill than for a VLOS; fewer communities would likely experience the levels of impacts documented for the EVOS. However, one or more communities could experience effects within their localized harvest areas based on the conditional analysis of potential for contact from a large spill (Section A-3.10.2.1). Contamination-related impacts caused by a large spill are expected to be long-lasting and widespread and possibly severe for subsistence harvest patterns and traditional practices.

A well control incident and gas release, with a possible explosion and fire could have impacts on subsistence resources (i.e., fish, birds, and marine and terrestrial mammals) in the immediate vicinity of the blowout. A release of methane into the water column has the potential to affect fish utilized as a subsistence resource (Section A-3.4). Fish mortality associated with a gas pipeline release could range from a few to hundreds of individuals without population-level impacts (Section A-3.4). Most gas escaping and contacting water would dissipate quickly, producing no effect on marine mammals hunted for subsistence purposes. If a 1-day natural gas pipeline release occurred, subsistence harvesters would likely avoid searching in the immediate vicinity for a short time period. If the release caused an explosion and fire, there is a chance subsistence resources in the vicinity would be injured or killed. A large natural gas release over one day is expected to have short-term and localized effects on subsistence harvest patterns in the Proposed Lease Sale Area.

A-3.10.2.1 Oil Spill Risk Analysis

BOEM identified 12 subsistence use areas (SUAs) for the analysis (Ji and Smith, 2021; Table A.1-9; Figures B-2a, d, and B-4a). The OSRA acronyms include ERA for Environmental Resource Area, and GLS for Grouped Land Segment.

Conditional Probabilities. Table A12 shows 9 SUAs with a ≥0.5 percent chance of contact in summer and winter. Figure A11 shows the location of these SUAs with a ≥0.5 percent chance of contact. Two of the SUAs are not estimated to be contacted (<0.5 percent chance). Four SUAs have a ≥6 percent chance of contact, of which, two have a ≥25–<50 percent chance of contact.

Table A12: Highest Percent Chance of a Large Oil Spill Contacting Subsistence Resources (Assuming a Large Spill Occurs)[1]

OSRA Feature Type	Highest Percent Chance	Summer: 30 days	Winter: 30 days
ERA	≥0.5–<6	2, 7, 8, 9	7, 8, 9
ERA	≥6–<25	5, 6	3, 5, 6
ERA	≥25–<50	3, 4	4
GLS	≥0.5–<6	116	--
Names of ERAs Contacted: 1 SUA: Tyonek Beluga; 2 SUA: Tyonek North; 3 SUA: Tyonek South; 4 SUA: Seldovia, Port Graham, Nanwalek; 5 SUA: Port Lions; 6 SUA: Ouzinke; 7 SUA: Larsen Bay; 8 SUA: Karluk; 9 SUA: Akhiok; 10 SUA: Old Harbor Names of GLSs Contacted: 116 Chignik, Chignik Lagoon			

Notes: [1] Highest percent chance from any launch area (LA) or pipeline area (PL) during summer or winter assuming a large spill occurs. Note that all resource areas with <0.5 percent chance of contact are not shown.
-- No highest percent chance in this range.
Source: Ji and Smith (2021).

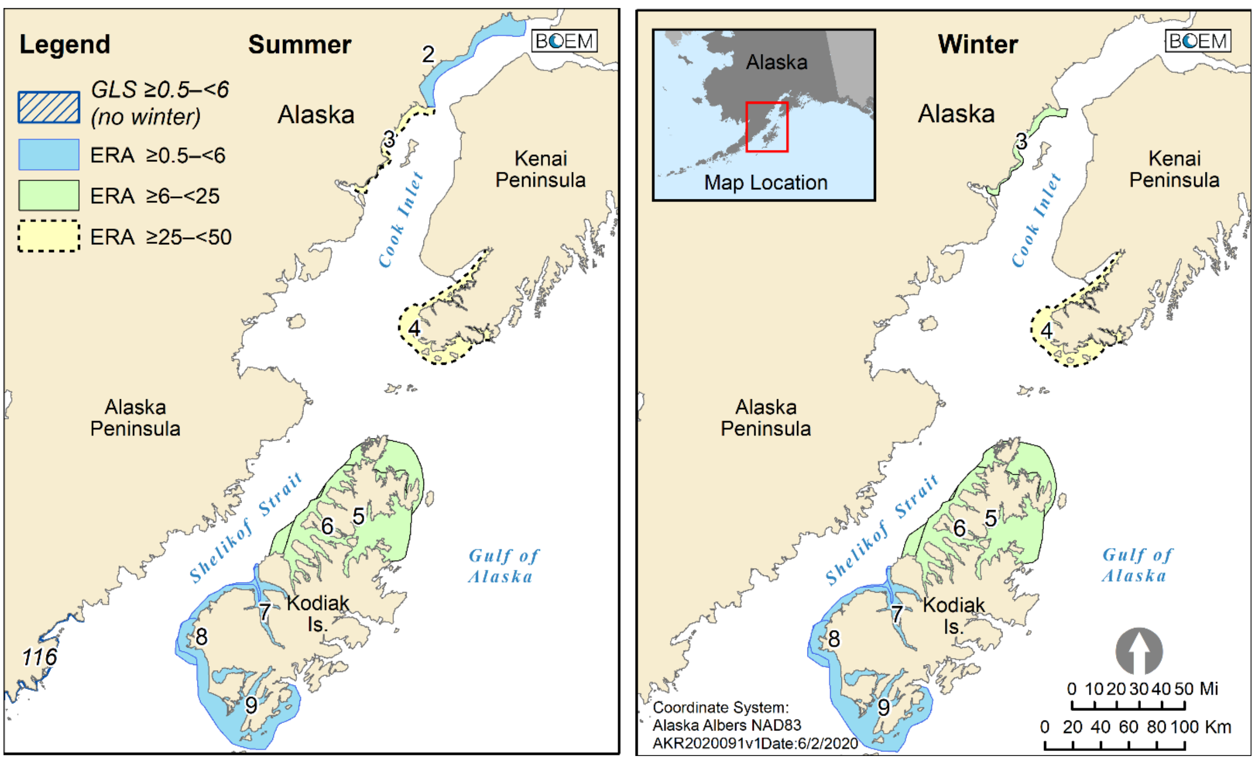


Figure A11: Location and ID number of Subsistence Use Areas (Assuming a Large Spill Occurs ≥1% Chance of Contact within 30 Days): Summer and Winter

Summer. SUAs used by Tyonek, Seldovia, Port Graham, Nanwalek, Larsen Bay, Karluk, Akhiok, Port Lions, Ouzinkie, and the Chigniks have a chance of contact from a large spill within 30 days or less. The Tyonek South (3) and Seldovia, Port Graham, Nanwalek (4) SUAs have the highest chance of contact ranging from ≥25–<50 percent. The northern Kodiak Island SUAs have the next highest chance of contact ranging from ≥6–<25 percent. SUAs farther to the north or south of the Lease Sale Area, Tyonek North (2) in upper Cook Inlet and the Chignik, Chignik Lagoon (116) on the Upper Alaska Peninsula, have a lower chance of contact (≥1–<6 percent).

Winter. The winter patterns are the same as discussed above for a summer spill, with the following notable differences. Chignik, Chignik Lagoon (116) and Tyonek North (2) are unlikely to be contacted (<0.5 percent). The percent chance of contact decreases for the Tyonek South (3) SUA to ≥6–<25 percent.

Combined Probabilities. Except for Tyonek South (3); Seldovia, Port Graham, Nanwalek (4); Port Lions (5); and Ouzinke (6) with a 1–2 percent chance of occurrence and contact, the combined probabilities for other SUAs were <0.5 percent (Ji and Smith, 2021, Tables A.2-61 and A.2-63).

A-3.10.3 Spill Drills and Response Activities

Spill drills, including GIUEs, are infrequent, short-term, and use existing equipment. If spill drills were carefully sited away from subsistence use areas or scheduled outside harvest seasons, they would have little to no impacts to subsistence activities and 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. If cleanup 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 restricted. Additionally, increased aircraft and vessel traffic and corresponding increases in vessel discharges and noise associated with spill cleanup operations would create disruptions and space-use conflicts that could extend beyond the immediate area of cleanup activities. Restriction of access to subsistence harvest areas could last for part of a harvest season or for one or more seasons. Impacts would be short-term and localized or long-lasting and widespread, depending on the area affected and the length and season of cleanup activities.

Mechanical methods used to recover spilled oil offshore would most likely not impact fishing practices or other subsistence activities because harvesters would avoid affected areas and active cleanup operations. The use of dispersants and in-situ burning could result in avoidance of harvesting marine resources for one or more harvest seasons due to potential contamination. The potential for contamination of wild foods could result in long-lasting and widespread cessation of subsistence harvest of marine resources including fish, invertebrates, and marine mammals.

Subsistence activities and harvest patterns could be affected by spill response and cleanup activities that involved volunteer or paid employment of residents. Subsistence harvesters' time, effort, and equipment could be diverted from subsistence activities to oil spill response and cleanup. Earning cash from paid work in spill response and cleanup may allow some subsistence harvesters to purchase newer equipment and fuel needed to effectively pursue subsistence activities. Impacts to subsistence harvest patterns caused by spill response and cleanup activities could be short-term and localized or long-lasting and widespread, depending on the extent and location of the spill.

A-3.10.4 Conclusion

Impacts to subsistence activities and harvest patterns could be negligible to minor for small spills. Impacts from a large oil spill could cause severe and thus major impacts to subsistence harvest patterns. Such impacts would be due to the potential to disrupt subsistence activities, or to make subsistence resources unavailable or undesirable for use—or only available in greatly reduced numbers—for a substantial portion of a subsistence season. A large gas release would be expected to have minor impacts to subsistence activities and harvest patterns. Spill drills would have negligible impacts to subsistence activities and harvest patterns. Spill response and cleanup would have minor to moderate impacts to subsistence activities.

A-3.11 Community Health

An oil spill or gas release could impact community health. Potential adverse impacts to health from large oil spills fall into four categories (Goldstein et al., 2011):

- Impacts related to worker safety
- Toxicological effects in workers, visitors, and community members
- Mental health effects from social and economic disruption
- Environmental effects that have consequences for human health

There is evidence in the literature of a positive relationship between exposure to spilled oils and the appearance of physical, psychological, endocrine, and gene-level effects in exposed humans, especially those involved in response and cleanup (Aguilera et al., 2010; Diaz, 2011). Large oil spills have caused serious mental health impacts such as post-traumatic stress disorder. Mental health impacts are caused by social disruption, income loss, loss of economic and subsistence resources, and high levels of worry over contamination of the environment and foods harvested from oiled environments (Eykelbosh, 2014; Grattan et al., 2011; Laffon et al., 2016; Osofsky et al., 2011; Palinkas, 2012).

Additional discussion of the general impacts of oil and gas on human health is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.10).

A-3.11.1 Small Oil Spills (<1,000 bbl)

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. Impacts on subsistence harvest patterns could decrease nutritional and social well-being (EIS Section 4.11). Most small spills would likely be contained on a vessel or facility and would occur outside communities, and exposure of community members would be limited. Impacts to community health from small accidental spills are expected to be no more than short-term and localized.

A-3.11.2 Large Oil Spill (≥1,000 bbl)/Gas Release

A large, 3,800 bbl oil spill could have mental health impacts for residents living in the affected area. For example, in Alaskan communities impacted by the EVOS, residents showed changes in indicators of post-traumatic stress including greater degrees of stress in the forms of recurrent, unprovoked, negative thoughts about the spill and avoidance behaviors such as suppression of thoughts and behaviors related to the spill (Picou et al., 1992). Indicators of personal and social stress were observed in community residents following the *Selendang Ayu* incident which spilled approximately 7,990 bbl of mixed fuels near Unalaska in the Aleutian Islands (Impact Assessment, Inc., 2011b). These observations suggest spills smaller than the EVOS can produce localized stress. A 3,800-bbl spill would be expected to have less extensive impacts on mental health than a VLOS, such as the EVOS, but similar effects could occur at a smaller scale in one or more communities. Impacts could range from short-term and localized to long-term and widespread, depending where spilled oil contacts shorelines in relation to communities and resource use areas.

A large oil spill that disrupts subsistence resources and harvest patterns (Section A-3.10) could result in long-lasting and widespread impacts to health in coastal communities. These impacts would primarily be realized through long-lasting, widespread, and potentially severe disruptions to subsistence practices, loss of harvest opportunities, and avoidance of subsistence resources (Section A-3.10). Impacts to community health and individual mental health would include compromised nutrition and general decreases in community organization and cultural well-being due to a lack of traditional foods and inability to engage in traditional practices such as sharing food with elders (Sections A-3.9 and A-3.10).

In the event of an offshore gas release of 20–30 million cubic feet occurring over one day, most gas escaping and contacting water would dissipate quickly, producing little to no effects to public health. While natural gas is a simple asphyxiate in confined spaces, the gas would dissipate quickly upon release. Upon reaching the surface, gaseous CH_4 would react with air, forming CO_2 and water, which would then disperse into the atmosphere. Temporary and localized impacts are possible from a 1-day large release of natural gas occurring at an onshore pipeline, especially if there was ignition and an explosion and fire near a community or near active subsistence harvesters. Air and water quality are not expected to be adversely affected to the point of affecting human health. Impacts to community health from a large gas release are expected to be short-term and localized.

A-3.11.3 Spill Drills and Response Activities

If spill drills including GIUEs were carefully sited away from communities and subsistence use areas, they would have little to no adverse impacts to community health.

Spill response and cleanup workers from both inside and outside communities could experience exposure to oil and its toxic components resulting in acute or chronic health impacts. Hazards to oil spill workers include drowning, cold exposure, falls, and back injuries. Additionally, impacts to community members related to social conflicts could occur when they work on spill response and cleanup alongside outside workers who may be unfamiliar with and insensitive to the cultures of Alaska Native peoples.

Impacts of spill response and cleanup activities on subsistence harvests would affect community health if they resulted in reduction of subsistence foods or stress about availability or quality of subsistence resources (Section A-3.10). Subsistence-related impacts could cause short-term and localized, or long-lasting and widespread impacts to community health related to the level of impact to subsistence harvest.

Increased employment in spill response could place stresses on community health infrastructure such as hospitals and health clinics by drawing local workers away from community service jobs or by increased medical visits from outside cleanup workers. These changes could increase healthcare demands and social conflicts between residents and outsiders. The deterioration of social relationships, anxiety, stress, and depression may result from long-term and widespread spill response and cleanup operations (Palinkas et al., 1993; BOEM, 2016). Potential impacts from cleanup efforts for a 3,800-bbl spill would range from short-term and localized to long-term and widespread depending on where cleanup efforts are based and the duration of cleanup efforts.

A-3.11.4 Conclusion

Impacts of small spills to public and community health are expected to be minor, because they would be short-term and localized. In the case of a large oil spill, impacts to public and community health could be short-term and localized to long-lasting and widespread, and thus minor to moderate, depending on the size and location of a spill and whether impacts disrupt resource harvest activities for one or more seasons, alter local health care provisions, disrupt traditional sharing networks, and/or threaten cultural values and identities. A large gas release is expected to have minor impacts to community health. Spill drills would have negligible adverse impacts to community health, and impacts from spill response and cleanup activities are expected to be minor to moderate.

A-3.12 Economy

Oil spills can have both adverse and/or beneficial impacts on local markets, employment, income, and revenues. Geography, type and amount of oil, social values, climatic conditions, laws, timing of the spill, and cleanup logistics all significantly affect an oil spill's economic impact (Etkin, 1999; White and Molloy, 2003; Xin and Wirtz, 2009). The three most important predictors of an impact are determined by its size, location, and the existing natural resources. The economic impacts of oil spills include:

- Mixed economy (market and subsistence economy) losses occur for communities dependent on the marine environment for subsistence resources (Impact Assessment, Inc. 1990, 2011a, b; McDowell Group, 1990; Picou et al., 2009).
- Local businesses incur losses caused by direct damage in the spill-affected area(s) (Cirer-Costa, 2015; Eastern Research Group, 2014; McDowell Group, 1990; Murtaugh, 2010; Ritchie et al., 2013).
- Increases in disaster response spending cause an increase in short-term employment, income, and revenues in the spill-affected areas (Cohen, 1993, 1997; Fall et al., 2001).
- Local governments experience revenue impacts (Impact Assessment, Inc., 1990, 2011a, b; Recovery and Relief Services, 2015).

Additional discussion of the general impacts of oil and gas on economy is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.9).

A-3.12.1 Small Oil Spills (<1,000 bbl)

Small spills would be contained to a limited area, and overall impacts would depend on the size and spill response time. Workers would consist of primarily on-site personnel with the exception of a 125-bbl spill which may include additional local oil spill response organization personnel. Wages earned and other economic impacts would range from no impacts to impacts that are short-term and localized.

A-3.12.2 Large Oil Spill (≥1,000 bbl)/Gas Release

The primary economic impacts of a large, 3.800 bbl oil spill would occur through response and cleanup efforts (discussed below). Some communities in the region participate in a mixed economy that relies on subsistence sharing. A large oil spill impacting subsistence (Section A-3.10) would have greater impacts on these participating communities than other, more market-based economies where resources are available for purchase. Commercial fisheries could be impacted as well. A large oil spill (3,100-bbl *Glacier Bay* tanker spill) occurred in upper Cook Inlet in 1987 and affected the salmon fisheries. Losses reported by driftnet fishers ranged from approximately $10 to $108 million; setnet fishers reported losses ranging from $12 to $82 million (MMS, 1990). Beyond subsistence and commercial fisheries, impacts to wages earned and other economic impacts would range from no impacts to impacts that are short-erm and localized. KPB oil and gas property taxes would not be impacted. The State of Alaska would have a short-term minor or negligible revenue loss associated with 8(g) zone petroleum revenue. A gas release would not have measurable economic impacts because the natural gas volume would not be substantially reduced during the 1-day event.

A-3.12.3 Spill Drills and Response Activities

While spill drills, including GIUEs, have little to no economic impact to affected communities, response and cleanup could provide economic benefits. Increases in disaster response spending can create a recovery boom that benefits any tourism business that provides accommodations and transportation for those participating in the recovery process. Recovery spending can also support local retailers, contractors, and workers displaced from primary industries. If local procurement for goods and services takes place after disasters, impacts on the local economy can increase short-term economic benefits (Chang et al., 2014).

Assessment of employment, income, and revenues for oil spill response is based on the most relevant historical experience of a spill in Alaskan waters—the 1989 EVOS—which was 240,000 bbl. Although orders of magnitude larger than a large spill, the EVOS event provides an illustrative example of what could happen on as smaller scale. EVOS generated substantial employment of up to 10,000 workers doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months of each year until 1992. EVOS also had adverse impacts on jobs and income associated with commercial and recreational fishing. During EVOS, numerous local residents quit their jobs to work on the cleanup, often at significantly higher wages. This generated additional adverse impacts in the form of sudden and significant inflation in the local economy (Cohen, 1993). This effect could also occur under the Spill Scenario, but at a smaller scale proportional to the volume spilled. Based on employment from EVOS, BOEM proportionally estimates a large spill of 3,800 bbl could generate up to 160 jobs. Local businesses may experience a shortage of workers because of the substantial increase in pay cleanup efforts provide. Cleanup efforts could last several seasons due to ice, but the majority of oil is expected to be removed within the first season. Therefore, the majority of the economic benefit in terms of wages earned would occur in the first year of spill response. This impact would provide a temporary and localized increase in household income in the local economy.

A-3.12.4 Conclusion

Economic impacts for affected communities range from negligible to minor for small spills, and up to minor for a large spill. For small spills, most of the cleanup would stem from those already working. However, for a large spill, up to 160 additional cleanup workers could be required which may provide a substantial, short-term amount of wages earned for the affected community. A large gas release or spill drills would have a negligible impact to the economy. Overall, spill response would have a negligible to minor impact.

A-3.13 Commercial Fishing

Oil spills can affect commercial fishing through impacts to the targeted species, or through direct effects on fishing gear or access to fishing grounds. Impacts could include:

- Federal and state waters closed to commercial fishing in an effort to protect seafood safety and ensure consumer confidence (McCrea Strub et al 2011; Moller et al. 1999; Ritchie, 1995).
- Perception of affected sites as unclean and unsafe to eat from which can undermine the image of the sites and reduce demand of commercially harvested species in the months following a spill (Choeng, 2012; Garza-Gil et al. 2006, Morgan et al 2016; Surís-Regueiro et al. 2007).
- Reduction in product, caused by direct mortality or habitat loss (Chang et al., 2014; Section A-3.4).
- Contamination of vessels and gear (ITOPF, 2014).

Effects of oil on targeted species are discussed in Section A-3.4 of this document. The economic cost of a large oil spill (Section A-3.12.2) to the commercial fishing industry is primarily due to fishing closures, real or perceived catch tainting, and gear contamination. Fouling of gear and equipment could occur, which would limit commercial fishing opportunities. Oil spills during the summer or fall seasons may result in the greatest impact to commercially important migratory species, such as salmon, because this is when they are most abundant and have sensitive life stages (eggs and juveniles) present in the region. Important spawning areas, including subtidal and intertidal habitats, could have small amounts of oil persist for years if contacted resulting in longer-term effects on the fish and invertebrates that rely on those areas. These effects can have cascading impacts on commercial fishers. The occurrence of a large spill during winter is likely to reduce the extent of closures and economic losses that would occur during the following spring and summer. There are fewer ongoing commercial fisheries in winter, so 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. Ice could contain and weather the oil, and most commercially important species are unlikely to be contacted. 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.

A-3.13.1 Small Oil Spills (<1,000 bbl)

The majority of small spills are estimated to be less than 50 bbl and are not expected to have population-level effects on commercially important fish or shellfish species (Section A-3.4); thus, they are unlikely to have impacts on commercial fishing operations. A crude oil spill of 125 bbl would persist longer in the environment and could result in short-term and localized impacts to commercial fishing opportunities if the spill occurred in a targeted fishing area. Most small spills are expected to be contained or rapidly weather; but if chronic small spills occurred near important habitat areas for commercially targeted fish, impacts may be felt during multiple fishing seasons. Rapid cleanup or containment could minimize the geographic extent of potential impacts to commercial fishing opportunities. Small spills are not expected to result in fishery closures or reduced market values of fish over the life of the Proposed Action.

A-3.13.2 Large Oil Spill (≥1,000 bbl)/Gas Release

A large, 3,800 bbl spill could depress numbers of fish in subpopulations of some commercially important fish or invertebrate species in Cook Inlet, although the level of effects would depend on a variety of factors (location, volume, trajectory of the spill, and the time of year, see Section A-3.4). 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 during peak salmon fishing could result in severe impacts to commercial fishing and major losses of income for commercial fishers.

A large oil spill may cause local fish stocks or subpopulations to decline, leading to fishery closures. These declines in population, however, are unlikely to affect the entirety of Cook Inlet migratory fish populations, and recovery within a few generations would be expected. Fisheries for groundfish are less likely to be closed than pelagic fish in the case of a large oil spill, because the target species occur at depths that are unlikely to be oiled and are not expected to come in contact with a floating oil slick. Regardless, groundfish could become commercially unacceptable for market due to actual or perceived contamination and tainting. Gear used to target commercially important species, such as longlines, seines, and gillnets, could be fouled with amounts of oil and become unfit for future use. A large oil spill before or during commercial fishing season could result in closures of high-value commercial fisheries to protect gear or harvests from potential contamination. A large spill could also result in large areas being closed to commercial fishing until cleanup operations or natural weathering occurred and oil concentrations are reduced to safe levels or the target population has recovered. This process can take years and could result in long-term, severe economic impacts. These possibly widespread fishing closures could have major adverse impacts to commercial fishers and their livelihoods. Spills originating near established fishing grounds have the greatest potential to affect commercial fishers.

A large gas release and ensuing explosion and fire could kill some commercially important species or damage fishing gear in the immediate area. Blowouts of natural gas condensates that did not burn would disperse rapidly at the blowout site and would be unlikely to affect commercial species populations or fishing gear. The impacts of a gas blowout and resulting explosion or fire are considered negligible to minor.

A-3.13.2.1 Oil Spill Risk Analysis

Specific resource areas were not defined for commercial fishing resources, since fishing occurs throughout the Proposed Lease Sale Area and targets several different species. OSRA results for anadromous fish, which are most likely to experience impacts from large spills, are be used to represent contact to commercial fishing since they are the targeted species most likely to be impacted by contact with oil.

OSRA results for anadromous fish resources (Table A5) estimate a large spill is likely to contact the western side of Cook Inlet in both summer and winter. 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 of occurrence and contact within 30 days range from 1–3 percent for the west side of Cook Inlet (LS 25, 28, 30–36) and to 1 percent for the east side of Cook Inlet (LS 56 and 62). Although unlikely, oil contact with the shore and nearshore environment could alter the migratory behavior of returning adult salmon and impact commercially important species 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.

A-3.13.3 Spill Drills and Response Activities

Spill drills, including GIUEs, would impact commercial fishing through vessel traffic, noise, and possibly through testing of mechanical recovery methods. Spill response activities could include mechanical recovery methods and in-situ burning of spilled materials, as well as use of dispersants (BOEM, 2019). Avoidance behavior of fish could affect availability of targeted species for commercial fishing, but these effects would be short-term and localized to the spill area.

The use of dispersants could result in impacts on targeted species as well as their preferred fish and invertebrate prey. These effects could be multi-generational and widespread for commercially harvested fish and shellfish if a large spill occurs and dispersants are used on eggs or juvenile fish. Effects would be limited spatially by the settling of oil and dispersant. Increased vessel traffic from drills and cleanup activities could cause space-use conflicts with commercial fishing vessels and closures of commercial fishing areas for cleanup activities could prevent fishing. 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.

A-3.13.4 Conclusion

Impacts from small spills would be minor because commercial fishers in the Cook Inlet would generally experience short-term, localized effects to target species and fishery closures are not anticipated and there would not be a clear, long-lasting change in this resource’s function. In contrast, large spills could have moderate 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 fish habitat areas were contaminated from a large oil spill and commercial fishing closures occurred during the peak salmon fishing period. 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 major impacts to commercial fishing in Cook Inlet, depending on the season and location of the spill. A large gas release would have negligible impacts on commercial fishing opportunities in Cook Inlet. Impacts of spill response and cleanup activities on commercial fisheries could range from minor to moderate. Spill drills are short-term and localized and are expected to have negligible impacts on commercial fishing, unless they overlap with ongoing fishing seasons.

A-3.14 Archaeological Resources

Oil spills, the use of chemical dispersants, and cleanup operations can have impacts on archaeological resources resulting in contamination, degradation, disturbance, or vandalism. These impacts can occur to sites both on land and underwater. Potential oil spill impacts to archaeological resources include:

- Oiling of known or unknown cultural or archaeological sites (Jesperson and Griffin, 1992; Reger et al., 2000; Wooley and Haggarty, 2013).
- Changes in the biodegradation rate of wood and the increase of soft-rot fungal activity in the presence of crude oil (Ejechi, 2003).
- Disruption of the composition and metabolic function of biota colonizing archaeological resources degrades wood and corrodes metal (Damour et al., 2019; Mugge et al., 2019; Salerno et al., 2018).

- Crude oil contamination of organic material used in C-14 dating; although there are methods for cleaning contaminated C-14 samples, greater expense is incurred (Dekin, 1993).
- Disturbance and potential vandalism to cultural or archaeological sites (Wooley and Haggerty, 2013; Reger et al., 2000).

Additional discussion of the general impacts of oil and gas on archaeological resources is provided in the *Beaufort Sea: Hypothetical Very Large Oil Spill and Gas Release* report (BOEM, 2020, Section 4.2.11).

A-3.14.1 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. Most of the volatile components of the fuel would evaporate and not impact seafloor archaeological resources. Small refined spills would likely have little to no impact as they are expected to disperse and volatize or be cleaned quickly. Small crude spills would persist longer in the environment and could affect shipwrecks or terrestrial surface sites through contamination from oiling. Small spills of crude oil could adhere to particles in the water column, sink, and impact a shipwreck site or exposed precontact site on the seafloor. However, due to the high-energy environment of Cook Inlet, it is expected that the portion of small crude spills that had not dispersed would be quickly transported away by strong currents (Johnson, 2008). Offshore small spills that reach the shoreline have potential for localized contact to resources in nearshore areas. Crude oil that may reach the shoreline or the seafloor is expected to be in low concentration and would have little or no impact, to potentially localized impacts, depending on the volume of oil that reaches an archaeological resource.

A-3.14.2 Large Oil Spill (≥1,000 bbl)/Gas Release

A large, 3.800 bbl spill of refined oil would float on the water surface and would disperse and weather rapidly. The volatile components of the fuel would evaporate and would be unlikely to affect seafloor archaeological resources. A large spill of crude oil would persist longer in the environment and could adhere to particulate matter in the water column, sink, and impact a shipwreck site or an exposed precontact site on the seafloor. Submerged materials are usually colonized by organisms and typically achieve a state of equilibrium that protects the material from further deterioration. Oil can destabilize this equilibrium, causing a die off of the biota protecting the site and increasing the potential for renewed degradation. Findings of field and laboratory studies conducted following the Deepwater Horizon spill indicate that exposure to oil and/or dispersants may alter bacterial community composition and corrosion potential of wooden and steel hulled shipwrecks and their debris fields (Damour et al., 2019; Mugge et al., 2019; Salerno et al., 2018). For a 3,800-bbl spill, impacts from such events are expected to be localized, affecting the immediate wreck area, but any damage would be irreversible, and therefore long-term. Impacts to a shipwreck would only occur if an oil spill intersected and contacted a shipwreck location.

Some archaeological resources in coastal land segments and intertidal zones could be directly exposed to oil and contaminated. Oil affecting larger areas of the coastline may have a higher potential to impact archaeological resources. BOEM estimates that up to 35 km of coastline could be oiled by a large crude oil spill (Table A2). Contamination by oil would make radiocarbon dating of a site difficult, because spilled oil would seep into charcoal, bone, wood, or other organic materials that would be used for radiocarbon dating (Dekin, 1993). A large refined or crude spill would be expected to have little or no impact if an archaeological resource is not oiled. If one or more resources are oiled, impacts could be long-term, and could be localized or widespread.

A gas release would dissipate rapidly, with no impact on submerged or coastal archaeological resources expected from exposure to gas. A large gas release that results in a blowout or explosion and possible fire could impact any archaeological resource in the vicinity of the blowout or explosion. Pre-drilling geohazard surveys should preclude the possibility of archaeological resources occurring within the immediate vicinity of well sites, which would reduce the expected impacts of a gas blowout and resulting explosion to little or no impacts. A large onshore gas release from a pipeline and potential explosion and fire could impact archaeological resources should ignition occur and if resources are in the vicinity. Although unlikely to occur, if an archaeological resource was damaged by an explosion or fire it could result in the loss or other permanent damage of the resource within the localized area of the incident. Performing pre-construction site clearance surveys in pipeline rights-of-way and creating avoidance boundaries around identified archaeological resources would reduce the possibility of an impact.

A-3.14.2.1 Oil Spill Risk Analysis

Archaeological resources such as historic shipwrecks, aircraft, and artifacts may be found anywhere within the OSRA study area or along the shoreline. Submerged shipwrecks, aircraft, and precontact sites located within the vicinity of the LAs (Figure A1) are at most risk of being impacted. BOEM identified 112 LSs for this analysis (Ji and Smith, 2021; Appendix A, Tables A.1-11; Figures B-3a–d). Table A4 and Figure A2, in Section A-3.3.2.1, display 39 LSs with a ≥1 percent chance of contact from any individual LA within 30 days summer or winter. The LAs closest to the shoreline have a ≥6 percent chance of contact to 11 individual LSs: Amakdedulia Cove, Bruin Bay, Chenik Head (28) to Redoubt Point (36) on the western side of Cook Inlet; and Cape Starichkof, Happy Valley (56); Barabara Point, Seldovia Bay (61); and Nanwalek, Port Graham (62) on the eastern side of Cook Inlet.

A-3.14.3 Spill Drills and Response Activities

Spill drills, including GIUEs, would be infrequent and localized and are expected to have little to no impact on submerged archaeological resources, because spill drill activities typically do not disturb the seafloor. Onshore impacts are also not expected as typical spill drills normally do not occur onshore.

Spill response and cleanup activities could damage some archaeological sites. Increased human activity, vessel anchoring and mooring, dispersants, and looting could all contribute to impacts on archaeological resources. Vessels involved in spill response may need to anchor at locations throughout the spill area. Anchors have the potential to contact and damage submerged archaeological resources. Additionally, like the impacts of oiling, introduction of dispersants into the marine environment may impact the resident microbial communities that colonize and provide a protective coating to submerged archaeological resources.

A main source of potential impact during spill response at shorelines and onshore is from looting and vandalism stemming from increased human presence around resources. Spill response workers have, at times, damaged or collected artifacts during response activities (Dekin et al., 1993; Wooley and Haggarty, 2013). Looting and vandalism could be mitigated by employing archeologists on the spill response teams and providing training to cleanup crews. Following proper procedures and cleanup protocols developed during and following the EVOS and Deepwater Horizon Oil Spill events would mitigate impacts of spill response. The first measure is avoidance, which could mitigate negative impacts by informing cleanup crews of culturally sensitive areas to avoid. This measure would require a cleanup crew supervisor to consult with archaeologists that inspected a site to advise on where planned cleanup could impact a cultural site. Additionally, spill response efforts would be coordinated with appropriate land managers to protect documented sites. Second, artifact collection under the management of an archaeologist would mitigate overall impacts to archaeological resources by preventing them from being harmed by cleanup activities or removed by cleanup workers. Third, education and training provided to cleanup crews could mitigate impacts by informing workers about the types of sites and artifacts to be aware of and instructing them on what to do and who to call should they find artifacts (Haggarty et al., 1991; Wooley and Haggarty, 1995).

In some cases, the discovery and reporting of archaeological sites could also result in their documentation and protection. For the EVOS, researchers concluded that <3 percent of the archaeological resources within the spill area suffered any significant impacts (Dekin et al., 1993; Wooley and Haggarty, 2013). While following the established spill response mitigation measures would mitigate most impacts, some impacts may still result in the loss of cultural or historic information. Onshore spills would not cover a large area, and therefore any spill cleanup and looting would be limited. Depending on whether a large spill contacted intertidal and onshore resources, response and cleanup time, and extent of response activities, impacts could be localized or widespread and long-lasting.

A-3.14.4 Conclusion

In the case of accidental spills, some impacts to shoreline archaeological and historic sites, historic shipwrecks, and submerged precontact archaeological resources may occur. Impacts from small spills would be negligible to minor because the oil is unlikely to contact archaeological resources, and any contact that does occur would be highly localized. A large oil spill could have moderate impacts based on the location of the spill and the proximity of archaeological resources. A large gas release resulting in a fire or explosion could have long-term and localized or widespread impacts in the unlikely event of ignition occurring and damaging nearby resource(s). Overall, the impact of a gas release is expected to be no more than minor. Spill response and cleanup could have moderate impacts on archaeological resources from impacts of vessel anchoring, dispersants, and damage caused by response personnel. GIUEs and spill drills would have negligible impacts on archaeological resources because they are not expected to contact a site.

A-3.15 Environmental Justice

Environmental justice (EJ) communities that could be impacted by oil and gas activities or oil spills in the Cook Inlet area are identified in Section 4.15 in the Lease Sale 258 EIS. These communities could potentially be disproportionately affected by adverse impacts from a large oil spill. In this EJ analysis, BOEM focuses on a large spill because no high and adverse (i.e., major) impacts are anticipated to occur from a gas release or small spills associated with the Proposed Action and alternatives (see EIS Table 3-4).

A large spill is expected to have major adverse impacts on subsistence harvest patterns and sociocultural systems, depending on location and timing. Impacts of a large spill on public and community health are expected to be long-lasting and widespread, and thus moderate for the Kenai Peninsula Borough, but have potential to be disproportionately felt in EJ communities due to their distinct cultural practices and subsistence ways of life. A large spill is also expected to have moderate impacts on water quality, and moderate to major impacts to coastal and estuarine habitats, which are important for EJ communities in the region that rely on a healthy marine ecosystem. EJ communities rely more on marine and coastal resources such as invertebrates, fish, and birds for subsistence purposes than other communities in the Proposed Lease Sale Area. Invertebrates and fish (Section A-3.4) are expected to be moderately impacted by a large oil spill, and impacts to birds would be moderate to major (Section A-3.5). Many subsistence users also fish commercially, reserving a portion of their harvest for subsistence use. Impacts of a large oil spill on commercial fisheries are expected to be major (Section A-3.13), and while the impacts affect communities throughout the Cook Inlet region, EJ communities that rely on fish, including fish gathered through a commercial harvest, could experience disproportionate impacts. Impacts of a large spill on marine and terrestrial mammals that are used for subsistence are expected to be minor (Section A-3.6 and Section A-3.7), and therefore would not affect EJ communities.

A large oil spill could result in contamination of subsistence foods and concerns of tainting of important marine resources. Contamination and damage to marine resources would likely cause disproportionately high and adverse effects to community health and well-being for EJ communities. These effects would arise from distress and disruptions to social organization and community cohesiveness that would be greater in extent and magnitude for EJ communities than non-EJ communities.

The OSRA model estimates, if a large oil spill occurred, oil could contact subsistence use areas (ERAs or GLSs) within 30 days. Subsistence use areas for Port Graham, Seldovia, Nanwalek, Tyonek, the Chigniks, Akhiok, Karluk, Larsen Bay, Ouzinkie, and Port Lions could be contacted by a large spill within 30 days or less. These communities are all identified as EJ communities, and they could be disproportionately affected if oil contacted their subsistence use areas.

If a large oil spill occurred and contaminated subsistence resources and harvest areas, disproportionately high and adverse effects could occur in EJ communities, especially when impacts from contamination of the shoreline, tainting concerns, spill response and cleanup disturbance, and disruption of subsistence practices are factored together. The adverse effects of a large spill event would be disproportionately felt by rural residents, predominantly Alaska Native Peoples, 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 communities on the southern coast of the upper Alaska Peninsula.

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