UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

September 13, 2017

Dr. James Kendall
Alaska Region Director
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Alaska OCS Region
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Anchorage, AK 99503-5823

Mr. Mark Fesmire
Alaska Region Director
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Alaska OCS Region
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Dear Dr. Kendall and Mr. Fesmire:

This letter transmits National Marine Fisheries Service's (NMFS) biological opinion on the effects of Cook Inlet Lease Sale 244 oil and gas leasing and exploration activities being proposed during the first incremental step (years 1-5 of activity on the Lease Sale) from August 2017 to August, 2022 by the Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement on threatened and endangered species in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

NMFS concludes the proposed action is not likely to jeopardize the continued existence of the endangered Cook Inlet beluga whale (*Delphinapterus leucas*), endangered fin whale (*Balaenoptera physalus*), endangered Western North Pacific Distinct Population Segment (DPS) humpback whale, threatened Mexico DPS humpback whale (*Megaptera novaeangliae*), or endangered western DPS Steller sea lion (*Eumatopias jubatus*), nor destroy or adversely modify critical habitat designated for the Cook Inlet beluga whale or Steller sea lion.

In formulating this opinion, NMFS used the best available scientific and commercial information, including the December, 2016, Final Environmental Impact Statement on the Effects of Oil and Gas Lease Sale 244 in the Cook Inlet, Alaska, the December, 2016, Biological Assessment for Oil and Gas Activities Associated with Lease Sale 244, updated project proposals, clarifying email and telephone conversations between NMFS and BOEM staff, and other sources of information. A complete record of this consultation is on file at NMFS's Juneau Alaska Office.

Conservation recommendations are provided with the opinion, which are intended to improve our understanding of the impacts of oil and gas activities on these animals.

Sincerely,

for Robert D Mecum

James W. Balsiger, Ph.D.
Administrator, Alaska Region

Enclosure
cc: Sharon Randall – BOEM (sharon.randall@boem.gov)
Craig Perham – BOEM (craig.perham@boem.gov)

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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion for Lease Sale 244, Cook Inlet, Alaska 2017-2022

NMFS Consultation Number: AKR-2016-9580

Action Agencies: Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE)

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversel y Affect Species?	Is the Action Likely to Adversely Affect Critical Habitat	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Cook Inlet Beluga Whale (*Delphinapterus leucas)*	Endangered	Yes	Yes	No	No
Fin Whale (*Balaneoptera physalus*)	Endangered	Yes	N/A	No	N/A
Humpback Whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	Yes	N/A	No	N/A
Humpback Whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	Yes	N/A	No	N/A
Steller Sea Lion, Western DPS (*Eumatopias jubatus)*	Endangered	Yes	Yes	No	No

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By:

for James W. Balsiger, Ph.D.
Regional Administrator

Date: September 13, 2017

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TERMS AND ABBREVIATIONS

µPa	Micro Pascal
2D	Two-Dimensional
3D	Three-Dimensional
ACIA	Arctic Climate Impact Assessment
AEWC	Alaska Eskimo Whaling Commission
AGL	Above Ground Level
APD	Application for Permit to Drill
API	American Petroleum Institute
ARBO	Arctic Regional Biological Opinion
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASL	Above Sea Level
ATOC	Acoustic Thermometry of the Ocean Climate
BA	Biological Assessment
Bbl	Barrels
Bbbl	Billion Barrels
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOSS	Bering Sea and Okhotsk Seas
BSAI	Bering Sea/Aleutian Island
BSEE	Bureau of Safety and Environmental Enforcement
BWASP	Bowhead Whale Feeding Ecology Study
CAA	Conflict Avoidance Agreement
CHIRP	Compressed High Intensity Radar Pulse
CI	Confidence Interval
CNP	Central North Pacific
CPUE	Catch Per Unit Effort
CSEL	Cumulative Sound Exposure Level
CSEM	Controlled Source Electromagnetic
CSESP	Chukchi Sea Environmental Studies Program
cui	Cubic Inches
CV	Coefficient of Variance

CWA	Clean Water Act
dB re 1µPa	Decibel referenced 1 microPascal
DDT	Dichloro-Diphenyltrichloroethane
District Court	U.S. District Court for the District of Alaska
DP	Dynamic Positioning
DPP	Development and Production Plan
DPS	Distinct Population Segment
DWH	Deepwater Horizon
E&D	Exploration and Development
EEZ	Exclusive Economic Zone
EP	Exploration Plan
EPA	Environmental Protection Agency
ERA	Environmental Resource Area
ERL	Effects Range Low
ERM	Effects Range Medium
ESA	Endangered Species Act
EZ	Exclusion Zone
ft	Feet
FWS	U.S. Fish and Wildlife Service
G&G	Geological & Geophysical
gal	Gallons
GLG	Growth Layer Group
Hz	Hertz
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITL	Information to Lessee
ITS	Incidental Take Statement
IWC	International Whaling Commission
km	Kilometers
kn	Knot
km2	Square Kilometers
L	Liters
LOWC	Loss of Well Control
LS 244	Lease Sale 244
m	Meter
mi	Mile
ms	Milliseconds

MLC	Mudline Cellar
MLC-ROV	Mudline Cellar Remotely Operated Vehicle
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MODU	Mobile Offshore Drilling Unit
MONM	Marine Operations Noise Model
MWCS	Marine Well Containment System
NEPA	National Environmental Policy Act
Ninth Circuit	U.S. Court of Appeals for the Ninth Circuit
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NTL	Notice to Lessee
OBC	Ocean Bottom Cable
OBN	Ocean Bottom Node
OC	Organochlorine
OCSLA	Outer Continental Shelf Lands Act
Opinion	Biological Opinion
OSR	Oil Spill Response
OSRA	Oil Spill Risk Analysis
OSRV	Oil Spill Response Vessel
OST	Oil Supply Tanker
OSV	Offshore Supply Vessels
PAH	Polycyclic Aromatic Hydrocarbons
PBDE	Polybrominated Diphenyl
PBR	Potential Biological Removal
PBU	Prudhoe Bay Unit
PCB	Polychlorinated Biphenyls
PCE	Primary Constituent Element
PR1	Office of Protected Resources- Permits and Conservation Division
psi	Pound Per Square Inch
PSO	Protected Species Observers
PTS	Permanent Threshold Shift
R95%	Radius of a Circle Encompassing 95% of the Area of the Contour
Rea	Radius of a Circle with Area Equivalent to the Total Area of the Contour

Rmax	Maximum Distance from Sound Source to the Contour
rms	Root Mean Square
RPA	Reasonable Prudent Alternative
SAE	SAExploration, Inc.
SDR	Satellite Data Recorder
SEIS	Supplemental Environmental Impact Statement
SONAR	Sound Navigation and Ranging
SPLASH	Structure of Populations, Levels of Abundance and Status of Humpback Whales
TAPS	Trans-Alaska Pipeline System
TGS	TGS-Nopec Geophysical Company ASA
TTS	Temporary Threshold Shift
USDOI	United States Department of Interior
USFWS	United States Fish and Wildlife Service
VGP	Vessel General Permit
VLOS	Very Large Oil Spill
VMS	Vessel Monitoring System
VSP	Vertical Seismic Profiling
WNP	Western North Pacific

1 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1536(a)(2)), requires each Federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a Federal agency's action "may affect" a protected species, that agency is required to consult with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)). Federal agencies may fulfill this general requirement informally if they conclude that an action may affect but "is not likely to adversely affect" endangered species, threatened species, or designated critical habitat, and NMFS or the USFWS concurs with that conclusion (50 CFR §402.14(b)).

For the actions described in this document, the action agencies are the U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE), which propose to lease areas for oil and gas exploration and authorize subsequent oil and gas exploration activities, and ensure environmental compliance of these activities associated with Lease Sale 244 (LS 244) blocks in Cook Inlet under the Outer Continental Shelf Lands Act (OCSLA) over a five-year period beginning August 2017 and ending August 2022. The consulting agency is NMFS's Alaska Regional Office.

BOEM/BSEE determined that the proposed action may affect, and is likely to adversely affect, Cook Inlet beluga whale, fin whale, Western North Pacific distinct population segment (DPS) humpback whale, Mexico DPS humpback whale, and western DPS Steller sea lion; and is not likely to destroy or adversely modify designated critical habitat for Cook Inlet beluga whales and Steller sea lions.

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS and/or USFWS provide an opinion stating how the Federal agency's action is likely to affect ESA-listed species and their critical habitat. If incidental take is reasonably certain to occur, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking, specifies those reasonable and prudent measures necessary or appropriate to minimize such impact, and sets forth terms and conditions to implement those measures. However, per NMFS's regulations, 50 CFR §402.14(i)(6) & §402.02, an ITS is not required at the programmatic level for framework programmatic actions where information on the specific number, location, timing, frequency, and intensity of actions is unknown; and any incidental take resulting from any actions subsequently authorized, funded, or carried out under the program will be addressed in separate ESA section 7 consultations.

The program addressed in this opinion is Lease Sale 244. A lease sale in and of itself will not affect marine mammals or result in the incidental take of listed species. However, if blocks are leased in the sale, the subsequent exploration, development, production, and decommissioning activities may affect listed species and designated critical habitat and may require subsequent consultation. First, the subsequent authorization of geological and geophysical exploration permits, ancillary activities, exploration plans, permits to drill, and development and production plans may affect listed species and may require project-specific consultation associated with the issuance of Marine Mammal Protection Act Incidental Harassment Authorizations or Letters of Authorization. In addition, subsequent authorizations at the exploration stage, including G&G permits, exploration plans, and a permit to drill, may affect listed species and may require BOEM and BSEE to initiate project-specific consultations for specific actions under this first incremental step. Finally, if commercially recoverable reserves are found and are proposed for development, BOEM and BSEE also may initiate consultation on future incremental steps associated with development, production, and decommissioning activities that affect listed species. Accordingly, consultation will be required for all activities related to this program (LS 244) that may affect listed species, and for each subsequent consultation NMFS will determine whether a future activity under this program is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of the critical habitat of such species. Moreover, at each step under this program (LS 244), project-specific information will aid in the assessment of effects on listed species and the amount and extent of incidental take resulting from that project; project-specific information also will aid in the development of sufficiently specific and meaningful terms and conditions for each project and will ensure an accurate and reliable trigger for reinitiation of consultation (80 FR 26832, 26835-36; May 11, 2015). For these reasons, NMFS will not be including an ITS with this opinion.

This is an incremental step programmatic consultation per 50 CFR §402.14(k),[1] with the first step consisting of leasing and exploration activities (years 1-5), and future steps consisting of development, production, and decommissioning activities (years 6-40) associated with the 224 current lease blocks covering approximately 1.08 million acres of seafloor in lower Cook Inlet. While the proposed action focuses on the first incremental step, we also consider potential impacts through the endpoint of the action (i.e., decommissioning activities). This consultation concludes whether the first incremental step violates section 7(a)(2) of the ESA, and also considers the reasonable likelihood the entire action violates section 7(a)(2), in accordance with 50 CFR §402.14(k). This document represents NMFS's biological opinion (opinion) on the effects of this proposal on endangered and threatened species and designated critical habitats.

The opinion was prepared by NMFS in accordance with section 7(b) of the ESA of 1973, as amended (16 U.S.C. §1536(b)), and implementing regulations at 50 CFR Part 402.

The opinion is in compliance with the Data Quality Act (44 U.S.C. §3504(d)(1)) and underwent pre-dissemination review.

1.1 Background

This opinion considers the effects of the authorization of oil and gas exploration activities for LS 244 under the OCSLA from September 2017 to September 2022. These actions have the potential to affect the endangered Cook Inlet beluga whale (*Delphinapterus leucas*), endangered fin whale (*Balaenoptera physalus*), endangered Western North Pacific DPS humpback whale, threatened Mexico DPS humpback whale (*Megaptera novaeangliae*), and endangered western

[1] Incremental step consultations are a type of programmatic consultation, and address a framework programmatic action as specified under 50 CFR §402.14(i)(6).

DPS Steller sea lion (*Eumatopias jubatus*), as well as the designated critical habitat for Cook Inlet beluga whale and Steller sea lion.

This biological opinion is based on information provided in the December 2016 Biological Assessment; revised February 2017 Biological Assessment; December 2016 Final Environmental Impact Statement (FEIS) on the Effects of Oil and Gas Activities in the Lease Sale 244 in Cook Inlet, Alaska; the updated project proposals; clarifying email and telephone conversations between NMFS and BOEM staff; and other sources of information. A complete record of this consultation is on file at NMFS's Anchorage, Alaska office.

1.2 Consultation History

- **November 27, 2013:** BOEM issued a Sale 244 Area Identification decision with map. The area identified consists of 224 blocks toward the southern part of Cook Inlet and the northern section of the Cook Inlet Leasing area; all of these blocks are available for lease through a blind auction, but it is unlikely that most blocks will be bid upon. It covers approximately 1.08 million acres [4,404 square kilometers (km^2)] of seafloor, stretching roughly from Kalgin Island in the north to Augustine Island in the south.
- **July 15, 2016:** BOEM issued a Draft EIS for LS 244 (BOEM 2016b) analyzing the possible environmental impacts of a potential oil and gas lease sale in Cook Inlet [Cook Inlet Outer Continental Shelf (OCS) Oil & Gas Lease Sale #244].
- **July 13, 2016:** BOEM/BSEE requested an incremental step consultation with NMFS under section 7(a)(2) of the ESA (BOEM/BSEE 2016b). The first incremental step consists of proposed activities associated with the leasing and subsequent exploration and delineation activities (activities determining the spatial extent of reserves) up to submission of a Development and Production Plan (DPP) for the 224 lease blocks within LS 244.
- **July 13, 2016:** NMFS received the BOEM/BSEE Draft Biological Assessment (BA) (BOEM/BSEE 2016a).
- **August 5, 2016:** NMFS responded to the request for consultation with a 30-day review letter, and requested that BOEM and BSEE clarify how effects to ESA-listed species or critical habitat from ancillary activities on lease would be covered under this consultation, given that: 1) an ITS is not being issued; 2) ancillary activities are conducted prior to an exploration plan (EP) or DPP being issued; and 3) ancillary activities do not require a separate permit from BOEM/BSEE that would trigger consultation (NMFS 2016).[2]
- **September 2, 2016:** NMFS sent comments and recommendations to BOEM after review of the DEIS associated with LS 244 (NMFS 2016b).
- **September 6, 2016:** BOEM and BSEE responded to NMFS's request, with a clarification that BOEM's regulations provide the flexibility to ensure that it has the ability to continue or reinitiate Section 7 consultation, as appropriate, based upon project-specific information (BOEM/BSEE 2016b).

[2] Because there is no ITS issued with this opinion, BOEM and BSEE will need to initiate or reinitiate consultation for all subsequent activities that may affect listed species, which will ensure take coverage for any incidental take reasonably likely to occur from those subsequent activities.

- **December 21, 2016:** BOEM sent a revised BA (BOEM 2016c), and Final EIS (BOEM 2016a).
- **January 11, 2017:** NMFS, pursuant to the Revised Interagency Cooperative Policy Regarding the Role of State Agencies in Endangered Species Act Activities, 81 FR 8663 (February 22, 2016), sent a notification letter to the Alaska Department of Fish and Game (ADF&G).
- **January 12, 2017:** NMFS sent a 30 Day Review letter pointing out missing information in the Revised December 21, 2016, BA.
- **January 31, 2017:** ADF&G provided two reports in response to the notification letter sent by NMFS on January 11, 2017.
- **February 8, 2017:** ADF&G provided an additional paper in response to the notification letter sent by NMFS on January 11, 2017.
- **February 17, 2017:** BOEM submitted the final BA for LS 244 (BOEM 2017b).
- **February 17, 2017:** NMFS initiated formal consultation.
- **February 17 – August 22, 2017:** NMFS sought and received from BOEM numerous clarifying emails regarding details of the action, including mitigation measures.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR §402.02).

This opinion considers the effects of BOEM and BSEE's leasing OCS blocks for oil and gas exploration activities (marine seismic, geohazard surveys, geotechnical surveys, and exploratory drilling), between August 2017 and August 2022. The proposed action would offer 224 OCS blocks contained within the northern portion of the Cook Inlet Planning area. The activities comprising the proposed action are further described below.

The purpose of the broader proposed action (of which this first incremental step is a part) is for BOEM and BSEE to manage the exploration, development, production, and decommissioning of oil and gas resources on leases issued through LS 244 in the U.S. OCS of Cook Inlet, Alaska, pursuant to the OCSLA. The OCSLA sets out a four-stage process for planning, leasing, exploration, and development and production of oil and gas resources in the OCS.

2.1 Incremental Step Consultation

Regulations at 50 CFR §402.14(k) allow incremental consultation on part of the entire action as long as the incremental step does not violate section 7(a)(2) or section 7(d) concerning irreversible or irretrievable commitment of resources; 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, obtains biological opinions, as required, for each incremental step, and obtains sufficient data upon which to base the final biological opinion on the entire action.

BOEM and BSEE requested incremental section 7 consultation with the proposed action covering the first step – leasing and exploration activities consisting of: (1) marine seismic surveys; (2) geohazard surveys; (3) geotechnical surveys; (4) exploratory drilling; and (5) onshore facility construction. The first incremental step consists of all activities associated with leasing and exploration and delineation of oil and gas resources in the proposed LS 244 area up to the submission of a Development and Production Plan (years 1-5).

Future incremental steps include all subsequent actions including: development, production, and decommissioning. As required, this consultation considers potential impacts through the endpoint of the action: the hypothetical Exploration and Development (E&D) Scenario (which includes exploration, development, and production activities), followed by the decommissioning of all of these activities (years 6-40).

2.2 BOEM and BSEE's Process for Permitting

Specific permits and authorizations required by BOEM and BSEE affect the progression of oil and gas exploration activities. The following summarizes BOEM and BSEE's permitting process:

- Geological & Geophysical (G&G) Exploration Permits – In accordance with 30 CFR Part 551, a permit must be obtained from BOEM prior to conducting geological or geophysical exploration on unleased lands or on lands under lease by a third party (off-lease activities). On-lease G&G exploration on lands under lease by the leasing party can be conducted under a G&G permit or an Ancillary Notice in accordance with 30 CFR Part 550 (on-lease activities). G&G exploration is defined in 30 CFR §551.1 (off-lease) and 30 CFR §550.105 (on-lease).
- Ancillary Activities – These on-lease activities include geohazard surveys, two-dimensional (2D) and three-dimensional (3D) deep penetration marine seismic, and geotechnical surveys. More specifically, ancillary activities include:

  (a) Geological and geophysical (G&G) explorations and development activities;

  (b) Geological and high-resolution geophysical, geotechnical, archaeological, biological, physical oceanographic, meteorological, socioeconomic, or other surveys; or

  (c) Studies that model potential oil and hazardous substance spills, drilling muds and cuttings discharges, projected air emissions, or potential hydrogen sulfide (H2S) releases.

  Ancillary activities are conducted in accordance with 30 CFR Part 550 (30 CFR §§550.207-550.210).
- Exploration Plan (EP) – An exploration plan is submitted to BOEM by the lessee to conduct exploration activities in accordance with 30 CFR Part 550 (30 CFR §§550.211-550.228). An EP is not required to conduct G&G or ancillary activities.
- Application for Permit to Drill (APD) – A permit must be obtained from BSEE prior to conducting drilling operations and requires detailed information on the seafloor and shallow seafloor conditions for the drill site from shallow geophysical surveys in accordance with 30 CFR Part 250 (30 CFR §§250.410-250.418).

The proposed action consists of ancillary activities (marine seismic surveys, geohazard surveys, and geotechnical surveys) that would be conducted by lease holders on their leased area(s) following the notice process under BOEM's regulations, and drilling activities that would be authorized under an exploration plan and a permit to drill. While BOEM's regulations concerning ancillary activities do not require a permit or other formal approval, the lessee must provide BOEM with advanced notice of the proposed ancillary activity. The notice gives BOEM the opportunity to review and ensure that the ancillary activity complies with performance standards referenced in 30 CFR §550.209 and listed in 30 CFR §550.202. This process allows BOEM to determine whether proposed ancillary activities may affect listed species or critical habitat. If an ancillary activity is likely to adversely affect listed species or critical habitat, BOEM and BSEE should initiate section 7 consultation with NMFS prior to any ancillary activities conducted on leases issued through LS 244.

If a lessee were to propose ancillary activities that may affect listed species or critical habitat, BOEM will notify the lessee that they cannot begin the proposed ancillary activities until: 1) the action is modified to eliminate the concern so there is no effect to listed resources or consultation has been completed with NMFS and/or FWS; and 2) an EP or DPP has been submitted and approved.

Off-lease G&G activities must obtain a G&G permit and an environmental review. These activities are not included as part of the proposed action but will undergo future consultation.

2.3 BOEM and BSEE's Proposed Activities

BOEM and BSEE propose to authorize a limited number of activities associated with exploration including marine seismic, geohazard surveys, geotechnical surveys, and exploratory drilling on blocks leased in LS 244 in Cook Inlet. The maximum anticipated level of exploration activity expected during the first incremental step can be seen in Table 1 and represents the exploratory activities possible from this first incremental step and analyzed in this biological opinion.

Table 1. Maximum anticipated level of exploration activities that would occur during the first incremental step (BOEM 2017b).

Activity Type	**Maximum Number During First Incremental Step**	**Activity Period[1]**
2D and 3D marine seismic survey	2	April-November
Geohazard survey	5	March-December
Geotechnical survey	5	March-December
Exploratory and delineation drilling	10 wells	Year-Round
Vertical Seismic Profiling	10	Year-Round
Oil spill response exercises	3 exercises per year	Year-Round

[1] See Section 2.10 Mitigation Measures where timing restrictions are further described.

The survey and drilling area, within the active leases, consists of 4,404 km^2 [1,701 square miles (mi^2)] (Figure 1).

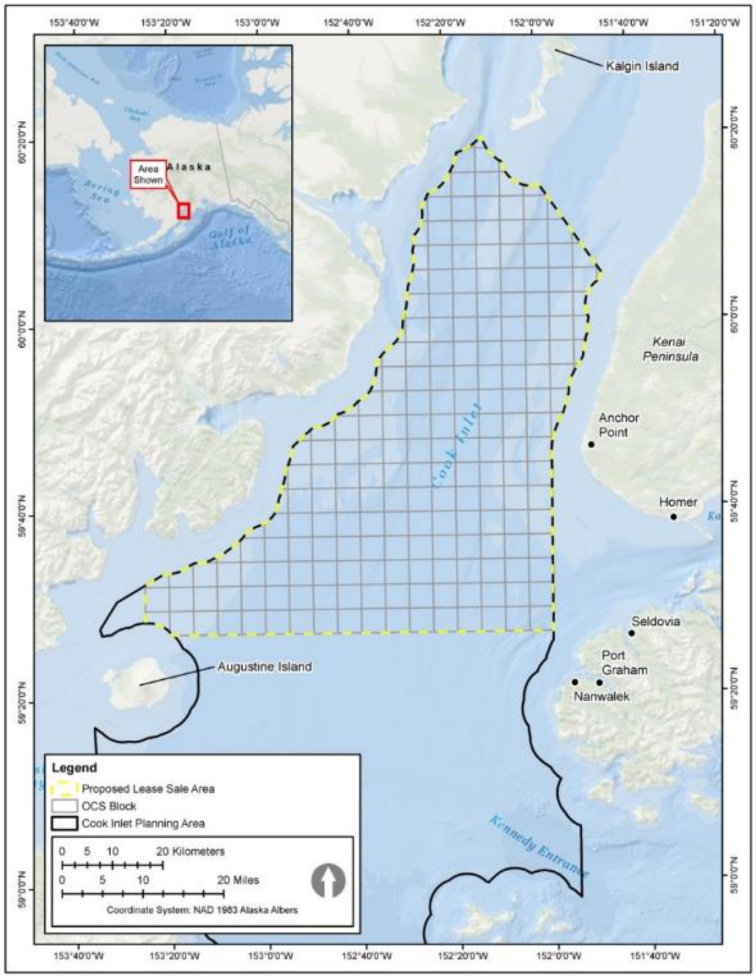

Figure 1. Cook Inlet Program Area and 224 Active Lease Blocks Included in LS 244 (BOEM 2017b).

2.3.1 Acoustic Equipment

Marine seismic and geohazard surveys, as well as exploratory drilling, may involve a variety of active and passive acoustic sources. Active systems are those that emit acoustic energy or sound into the water. Passive acoustic systems do not generate acoustic energy in the water, but are used to listen for sound in the water.

The active acoustic systems under the proposed action include devices for seismic reflection profiling, such as airgun arrays and subbottom profilers; sonar devices, such as echosounders, and sidescan sonar; and other sources of noise, such as vessels and aircraft (BOEM 2017b) (Table 2).

The E&D Scenario considers two types of active acoustics: 1) marine seismic surveys, which generally cover a larger area of leased acreage, and 2) geohazard surveys, which use both high-resolution seismic and sonar equipment and which are conducted on a more specific site to detect archeological resources or seafloor features that might be hazardous to operations, such as drilling a well or installing a platform or pipeline. Geohazard surveys may be accompanied by geotechnical surveys, which involve sampling or measuring mechanical properties or stability of near-seafloor sediments.

Detailed descriptions of marine seismic surveys, geohazard surveys, geotechnical surveys, and exploratory drilling are provided in Sections 1.4 and 1.5 of the Final EIS (BOEM 2016a), and in Section 2.2.1 of the BA (BOEM 2017b), and are incorporated here by reference and discussed below.

2.3.2 Marine Seismic Surveys

Marine seismic surveys (also known as deep penetration seismic surveys) are a type of ancillary survey conducted to identify prospective oil and gas deposits and to optimize drilling sites on leases acquired in lease sales. Different types of marine seismic surveys include: towed streamer 2D or 3D surveys, ocean bottom cable (OBC), and ocean bottom node (OBN). Marine seismic surveys would primarily occur between April and November[3].

Under the proposed action, two marine surveys would be conducted during the first incremental step (Table 1). The most likely staging area for seismic exploration would be Kenai/Nikiski, Alaska, or Homer, Alaska.

Towed 2D/3D Surveys
Two-dimensional (2D) marine seismic surveying techniques are used to provide broad-scale information over a relatively large area and are mostly used for pre-lease exploration or to provide geologic information. 3D deep marine seismic surveys are conducted on a closely spaced grid pattern that provides a more detailed image of the prospect, which is used to select the proposed drilling locations. BOEM assumes that most of the additional marine seismic surveys in the LS 244 area would be 3D surveys focusing on specific on-lease targets to identify possible drilling locations. Off-lease 2D/3D marine seismic surveys are typically conducted prior to a lease sale. Any future off-lease surveys will also be considered in future, site-specific consultations when NMFS receives permit applications in connection with those surveys. Accordingly, the effects from off-lease 2D/3D marine seismic surveys are not considered in this consultation.

OBN/OBC Surveys
Ocean bottom node (OBN) and ocean bottom cable (OBC) seismic surveys are commonly used in Cook Inlet primarily to acquire seismic data in transitional zones where water is too shallow for a seismic survey vessel and/or where the tides make acquisition with towed streamers very difficult due to problems keeping the streamer straight in the tidal currents. An OBN or OBC operation begins by deploying nodes or cables off the back of the layout boat. Cable or node length typically is 4 to 8 km (2.5 to 5 mi) but can be up to 12 km (7.5 mi). Lines of seismic-survey nodal receivers are attached to the rope in intervals typically of 40 to 60 m (131 to 197 ft). Multiple lines of nodes or cables are laid on the seafloor parallel to each other, with a cable spacing of between hundreds of meters to several kilometers, depending on the geophysical objective of the seismic survey. The OBN seismic source arrays are smaller in size than the

[3] See timing restriction for beluga whale critical habitat and drift gillnetting season (BOEM 2017b).

towed marine streamer arrays when the survey occurs in shallower water depths in which OBN surveys often are conducted (BOEM 2017b).

Noise Sources

Airguns are the typical acoustic sound source for 2D and 3D deep penetration seismic surveys. An outgoing sound signal is created by releasing a high-pressure air pulse from the airguns into the water to produce an air-filled cavity (a bubble) that expands and contracts. The size of individual airguns (volume of air released with each shot of the array) can range from tens to thousands of cubic inches (in^3). A group of airguns is usually deployed in an array to produce a more downward-focused sound signal. While airgun array volumes for both 2D and 3D seismic surveys can range from 1,800 to 6,000 in^3, no arrays large than 2,400 in^3 have recently been shot in Cook Inlet, and there is no information to indicate that a larger array would be needed or likely in the future. The energy output of the array is determined more by the number of guns deployed than by the total array volume (Fontana, 2003, pers. commun.). Airguns are fired at short, regular intervals, so the arrays emit pulsed, rather than continuous, sound. While most of the energy is focused downward and while the short duration of each pulse limits the total energy into the water column, the sound can propagate horizontally for several kilometers (Greene and Richardson 1988, Hall et al. 1994).

The sound source level (zero-to-peak) associated with typical marine seismic surveys ranges between 233 and 255 decibels re 1 microPascal at 1 meter (dB re 1 μPa @ 1 m), with most of the energy emitted between 10 and 120 hertz (Hz). However, source levels for airguns used during a recent survey by Apache conducted in Cook Inlet were 225 dB re 1 μPa @ 1 m for a 440 in^3 airgun array and 238 dB re 1 μPa @ 1 m for a 2,400 in^3 airgun array (Austin and Warner 2012, NMFS 2016a) (Table 3). A source array is activated approximately every 10 to 15 seconds, depending on vessel speed. The timing between outgoing sound signals can vary for different surveys to achieve the desired "shot point" spacing to meet the geological objectives of the survey; typical spacing is either 25 or 37.5 m (82 or 123 ft), but may vary depending on the objective of the survey. Airguns can be fired between 20 and 70 times per km.

For OBN and OBC surveys, once the sound receiver cables/nodes are in place on the seafloor, a vessel towing the source array passes over the sound receiver cables/nodes with the sound source being activated every 25 or 37.5 m (82 or 123 ft). The sound source may be a single array, or an array of multiple airguns, which is similar to the 2D and 3D marine seismic surveys.

OBN surveys may use an acoustical positioning system (or "pinger" system) to position and locate nodes placed on the seafloor. The pinger system consists of a vessel-mounted transceiver and transponders that attached to nodes. The transceiver uses sonar to communicate with the transponders, which in turn emit a response pulse. A pinger system recently used by SAE in Cook Inlet consisted of a transceiver that generated sonar at transmission source levels of 197 dB re 1 µPa (rms) at frequencies between 35 and 55 kilohertz (kHz) and a transponder that produced short pulses of 184-187 dB re 1 µPa (rms) at frequencies also between 35 and 55 kHz (Fairweather 2015). See Table 2 for summary of noise sources.

Vessel Information

The vessels conducting these surveys generally are 70 to 120 m (230 to 394 ft) long. Vessels tow one to three source arrays of six to nine airguns each, depending on the survey design specifications required for the geologic target. Most operations use a single source vessel. Marine 3D surveys are acquired at typical vessel speeds of 4.5 knots (kn) (8.3 km/hour). Vessel transit speeds are highly variable, ranging from 8 to 20 kn (14.8 to 37.0 km/hour) depending on a number of factors including, but not limited to, the vessel itself, sea state, and urgency (the need to run at top speed versus normal cruising speed) (BOEM 2017b).

However, more than one source vessel will be used when using smaller vessels due to working in shallow waters that cannot provide a large enough platform for the total seismic airgun array necessary to obtain target depth (such as for OBN or OBC surveys). The overall energy output for the permitted activity will be the same, but firing of source arrays on individual vessels will be alternated. Table 2 provides information on anticipated source levels associated with vessels.

Seismic vessels operate day and night, and a survey may continue for days, weeks, or months, depending on the size of the survey, data-acquisition capabilities of the vessel, and weather conditions. Vessel operation time includes not only data collection, but also deployment and retrieval of gear, line turns between survey lines, equipment repair, and other planned or unplanned operations.

The 2D seismic survey vessels generally are smaller than 3D survey vessels; larger 3D survey vessels also are able to conduct 2D surveys. For 2D seismic surveys, the source array typically consists of three or more sub-arrays of six to nine airgun sources each, but may vary as newer technology is developed. Only one streamer is towed during 2D operations. Seismic vessels acquiring 2D data are able to acquire data at 4 to 5 kn (7.4 to 9.3 km/hour) and collect data from multiple transect lines, totaling between 137 and 177 line km (85 and 110 line miles) per day, depending on the distance between line changes, weather conditions, and downtime for equipment problems (BOEM 2017b).

The OBN seismic survey requires the use of multiple vessels (Table 2). A typical survey includes: (a) two vessels for cable or node layout/pickup; (b) one vessel for recording (ocean bottom cable (OBC) only); (c) one or two source vessels; and (d) possibly one to three smaller [10 to 15 m (33 to 49 ft)] utility boats. It is unlikely that helicopters may be used for vessel support and crew changes if there are no safety concerns.

An additional support vessel may be used to monitor for marine mammals ahead of all seismic survey vessels (BOEM 2017b).

2.3.3 Geohazard Surveys

Geohazard surveys are another type of ancillary activity used to identify and characterize potentially hazardous conditions at or below the seafloor. They also identify potential benthic biological communities or habitats and archaeological resources (BOEM 2017b). Geohazard surveys are also called high-resolution, site clearance, and shallow hazard surveys. BOEM assumes that a lessee would proceed from marine seismic exploration of a prospect to exploratory and delineation drilling. At least one year prior to drilling exploratory wells, the lessee would conduct geohazard surveys to further evaluate the prospective site.

Prior to submitting an EP or DPP, oil and gas industry operators are required to evaluate any potential geological hazards and document any potential cultural resources or benthic communities pursuant to 30 CFR Part 550. Site clearance, geohazard surveys are conducted as ancillary activities on an oil and gas lease to meet these requirements. BOEM has provided guidelines in Notices to Lessees (NTLs) 2005-A01, 2005-A02, and 2005-A03 that require collection of high-resolution shallow hazards surveys to ensure safe conduct and operations in the OCS at drill sites and along pipeline corridors, unless the operator can demonstrate that there is sufficient existing data to evaluate the site. BOEM assumes that four to five geohazard surveys could be conducted during the first three years of the E&D Scenario (Table 1). Surveys would most likely occur during ice free months (March to mid-December).[4]

Noise Sources

The suite of equipment used during a typical shallow hazards survey consists of single beam and/or multibeam echosounders, side scan sonar, sub-bottom profiler, bubble pulser or boomer, and small airgun (array) with a multichannel streamer. In addition, magnetometers may be used to detect ferrous items, but this has not been required in the Alaska OCS to date (BOEM 2017b).

Typical acoustic characteristics of these sources are summarized in Richardson et al. (1995) as follows (and summarized in Table 3):

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

2.3.4 Geotechnical Surveys

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

BOEM assumes that four to five geotechnical surveys could be conducted during the first three years of the E&D Scenario. As previously described for marine seismic and geohazard activities, surveys could occur during any period without ice formation but likely will occur in April to November (BOEM 2017b).

2.3.5 Exploration and Delineation Drilling Operations

Operators will select locations for exploratory wells based on targets delineated while mapping subsurface structures from 2D and 3D deep-penetration seismic data and historical well information. As required by regulation, the sites will be clear of geologic hazards, archeological features, and biological populations prior to drilling exploration wells (BOEM 2017b).

[4] Except as described in Table 1 (see timing restriction for beluga whale critical habitat and drift gillnetting season) (BOEM 2017b).

Based upon the expected water depths in the proposed Lease Sale 244 area and recent exploration activities, it is likely that a jack-up rig will be utilized for exploration drilling, but drillships remains a possibility. BOEM estimates a maximum of three wells could be drilled, tested, and plugged per rig or ship during a single drilling season (with a total of 10 wells for the entire first incremental step). Drilling operations are expected to range between 30 and 60 days per well, depending on the substrate, depth of the well, delays during drilling, and time needed for downhole well logging and testing operations.

During the summer, the lower Cook Inlet is a high-use commercial and recreational fishery area. These activities may limit or interfere with drilling operations. While the proposed Cook Inlet OCS Lease Sale 244 area remains relatively ice-free during the winter, the unpredictable winter weather conditions may limit drilling operations either by logistics, or the additional expense required to conduct winter operations.

If there is a discovery during exploratory drilling, the operator will drill additional delineation wells to establish the areal extent of economic production. If the delineation wells verify sufficient volumes of oil or gas and if the expense of production including a platform and pipeline is justified, there may be as many as ten wells drilled during exploration on prospects in the lease sale. Noise associated with exploratory drilling is expected to derive from pile driving when a jack-up rig is used or from thrusters and anchor-handling when a drillship is used. Additional sources of noise associated with drilling derive from drilling equipment, vertical seismic profiling, and geotechnical and geohazard surveys. BOEM anticipates drilling will predominantly be conducted by jack-up rig in Cook Inlet (BOEM 2017b).

Jack-up Rig

A jack-up rig is an offshore structure composed of a hull, support legs, and a lifting system that allows it to be towed to a site, lower its legs into the seabed and elevate its hull to provide a stable work deck. When a jack-up rig comes on site, the legs are lowered to the seafloor and preloaded to simulate the maximum expected load. This ensures the supporting soil will provide a reliable foundation after the rig is jacked up to the maximum height above the water (air gap). The actual dimensions of a jack-up rig would depend on the environment in which the unit would be operating and the maximum operating water depth. A typical jack up rig for use in up to 50 m (164 ft) of water is approximately 50 m (164 ft) in length, 44 m (144 ft) beam, and 7 m (23 ft) deep (BOEM 2017b).

Marine Acoustics (2011) performed underwater sound source verification (SSV) in Cook Inlet for the *Spartan 151* jack-up drilling rig. The rig was located in 24.4 to 27.4 m (80 to 90 ft) water depth within the Kitchen Lights Unit, 12 miles northeast of Nikiski Bay. The major sources of sound were the diesel engines, mud pump, ventilation fans, and electrical generators, with the loudest source being the diesel generators. None of the measured sound exceeded the 180 dB re 1 µPa or 160 dB re 1 µPa thresholds. Non-continuous sound levels in the frequency band between 8.9 Hz to 44.7 Hz that exceeded 120 dB re 1 µPa were measured to a range of 1.17km to 1.4 km (3839 – 4593 ft). The source level of the diesel engines was estimated to be 137 dB re 1 µPa @ 1 m (rms) in the 141-178 Hz ⅓ octave band. From this, the 120 dB re 1 µPa acoustic received level isopleth would be 50 m (154 ft).

Jasco Applied Sciences performed SSV on the *Randolph Yost* jack-up drilling rig in water approximately 23 m (75 ft) deep at a well site in the Kitchen Lights Unit near Nikiski, Alaska (Denes and Austin 2016a). Noise sources included vessels approaching, departing, and holding station near the drill rig, deep well pumps, mud pumps, and drilling. The loudest identifiable sources were vessel thrusters, which had best fit and 90 percent fit 120 dB threshold ranges of 3.4 and 4.6 km (2.1 and 2.9 mi) respectively. The source level for drilling on the *Yost* was determined to be 158 dB using 90% fit to the data. The distance to the 120 dB isopleth was estimated to be ~330 meters for the 90% fit to the data (Denes and Austin 2016a). SSV from *Yost* was used as the best available data for the exposure analysis in this biological opinion.

Pile Installation

BOEM did not anticipate the use of pile driving during the first incremental step. However, recent exploration drilling operations in Cook Inlet[5] have required the installation of a drive pipe in order to support the initial sedimentary part of the well, preventing the surface layers from collapsing and obstructing the wellbore. The pipe also facilitates the return of cutting from the drill head. Drive pipes are usually installed using drilling, impact pile driving, or a combination of these techniques. The drive pipe is also used as a foundation for the wellhead (Jacobs Engineering 2017). For a 2017 Kitchen Lights installation in Cook Inlet by Furie, a drive pipe was to be installed using an impact hammer, and was expected to be driven downwards to about 150 feet below the seafloor. Pile driving is expected to take 8-10 hours per pile, spread over two to three days (Jacobs Engineering 2017).

SSV measurements were made when a jack-up rig drive pile was set using the Delmag D62-22 for 30-inch pile installation at Buccaneer’s Southern Cross lease in 2013. Based on this previous study with the same equipment in a nearby area of Cook Inlet, the anticipated source level for the D62-22 hammer is 190 dB re 1 μPa at 55 m (Illingworth and Rodkin 2014). Using the practical spreading loss model, in-water sound is expected to attenuate to 160 dB at 5,500 m.

2.3.6 Seafloor Disturbance

Exploration and delineation drilling will disturb an area of the seafloor from the displacement of sediments from the mud cellar, jack up legs, and drill hole discharge. The total area of disturbed seafloor will depend on the number of wells drilled, oceanographic parameters, and environmental factors.

It is estimated that each site at a jack-up rig disturbs a seafloor area of approximately 1 ha (2.5 ac) (BOEM 2012a). Approximately 10 ha (25 ac) of seafloor could be disturbed as a result of jack-up rig placement, assuming 10 exploration and delineation wells as part of the proposed action.

2.3.7 Vertical Seismic Profiling

Vertical seismic profiling (VSP) is a geotechnical survey technique carried out by using geophone receivers (sensor string) located on a cable and placed in a borehole at different depths

[5] See Cosmopolitan 90-day report (Owl Ridge 2014), Furie Biological Evaluation (Jacobs Engineering 2017).

to record acoustic signals from an external acoustic source near the wellbore (zero-offset VSP) or from a vessel at different distances from the wellbore (walk-away VSP).

In all VSP surveys, sensors are lowered down a borehole before production tubing is placed in the wellbore or the well is abandoned. The sensors lowered down the borehole can be connected together in strings of 16-36 receivers spaced from 15-150 m (49-492 ft) apart, depending on the survey objective and other variables. After lowering the sensor string to the lowest portion of the borehole to be surveyed, the sensors are temporarily attached via a mechanical caliper that clamps to the side of the wellbore and seismic signals are recorded. Subsequently, the sensor string is repositioned and the next set of seismic signals are recorded. Seismic sources used in VSP surveys are the same as those used in conventional 2D and 3D seismic airgun surveys.

Zero offset VSP surveys are typically conducted using a single airgun suspended approximately 10 m below the sea surface by a crane located on the deck of the drilling rig. Walk-away VSP surveys utilize a workboat with four to eight airguns towed 7-10 m (23-33 ft) below the surface. These surveys involve a source vessel firing at varying distances from the receivers within the borehole. The airgun arrays used for these surveys can vary in volume, depending upon the survey objective. One version of walk-away surveys requires the source vessel to travel in a spiral track. The source vessel begins the spiral track at a distance of 200 m (656 ft) from the borehole and keeps the distance between spirals equal to the number of arrays times the array separation. Airgun arrays are fired in an alternating fashion with the first array firing followed by the second array 11-14 s later. At a typical vessel speed of 8.3-9.3 km/hr (4.5-5 knots), the distance between firings is between 28 and 36 m (92 and 118 ft). The source vessel continues firing on the spiral path out to a distance of up to 9 km (4.9 nmi). If the borehole sensor string needs to be raised to another level, the whole procedure is repeated.

Survey duration depends on the type of survey, objectives, cost of the drilling rig, and equipment used. A zero-offset survey can take less than a day to complete. A walk-away survey can be completed in less than one day or may require up to 10 days to complete, however, 30 percent of that time may be with the airguns in standby mode.

VSP operations are not considered to be a marine seismic survey for analysis purposes in this opinion, but rather as part of an exploratory drilling program, even though airguns are used for a short time. It is unlikely that VSPs would be conducted at every exploratory and delineation well. However, for the purposes of this opinion, NMFS assumes that VSP would be conducted in association with each wellbore, resulting in a maximum of 10 VSP occurring during the first incremental step. VSP operations are anticipated to use a 500 in^3 array with a source level of 228 dB re 1 µPa rms (BOEM 2017b) (Table 3 for additional information).

2.3.8 Vessel and Aircraft Operations

During the first incremental step under the Proposed Action (all geophysical and geotechnical studies) marine vessels (M/Vs) would be the primary form of transportation, but aircraft may be used as well (Table 2). The number of vessels would depend largely upon the type of survey being conducted. Aircraft would support exploratory drilling activities and could be used during government-initiated oil spill response exercises.

Both helicopters and supply vessels would support operations during exploration drilling (Table 2). Each drilling rig could expect one to three helicopter flights per day and one to two support vessel trips per week. Nikiski or Homer would be the most likely operational base for these support activities.

The numbers and types of transportation used during government-initiated oil spill response exercises would vary dependent on the exercise but would likely include vessels (e.g., Oil Spill Response Vessels (OSRVs), M/Vs, containment barges, skiffs), helicopters, fixed-wing aircraft, and terrestrial transportation (Table 2).

Table 2. Summary of activities and support vessels associated with first incremental step activities (BOEM 2017b).

Activity	Year(s)	Timing Restrictions	Estimated Operations	Associated Transportation
Geophysical and Geotechnical Surveys				
3D marine seismic surveys	1-2	Not allowed on any OCS block in beluga whale critical habitat between Nov 1 and Apr 1 (waiver possible) Not allowed on beluga whale nearshore feeding areas OCS blocks within 10 miles of anadromous streams between July 1 and Sept. 30 Not allowed on any OCS block above Anchor Point during drift gillnetting season (usually mid-June to mid-Aug)	1-2 surveys total. Survey methods could include towed streamer, ocean bottom node (OBN), and ocean bottom cable (OBC).	For towed streamer: 1+ vessel. For OBN: 2 node layout/pick up vessels, 1-2 source vessels, possibly 1-3 smaller utility boats. For OBC: Same as OBN plus 1 vessel for recording. For all survey types an additional vessel for marine mammal monitoring may be needed. No aircraft.
Geohazard surveys	1-3	Not allowed on any OCS block in beluga whale critical habitat between Nov 1 and Apr 1 (waiver possible) Not allowed on any OCS block above Anchor Point during drift gillnetting season (usually mid-June to mid-Aug)	4-5 surveys total. Equipment/methods could include: echosounders, side scan sonar, subbottom profilers, bubble pulsers or boomers, controlled source electromagnetic sounding.	1 survey vessel. An additional vessel for marine mammal monitoring may be needed. No aircraft.
Geotechnical surveys	1-3	Not allowed on any OCS block in beluga whale critical habitat between Nov 1 and Apr 1 (waiver possible) Not allowed on any OCS block above Anchor Point during drift gillnetting season (usually mid-June to mid-Aug)	4-5 surveys total.	1 vessel or drilling barge. No aircraft.

Activity	Year(s)	Timing Restrictions	Estimated Operations	Associated Transportation
Exploratory Drilling Operations				
Exploration and delineation drilling	2-5	Not allowed on beluga whale critical habitat OCS blocks between November 1 and April 1 (waiver possible)	A maximum of 3 wells per drilling rig could be drilled, tested, and plugged per drilling season. Drilling would take 30-60 days per well. A total of 7-10 exploration and delineation wells would be drilled (including dry holes and additional unsuccessful wells from other Cook Inlet OCS prospects).	1-2 drilling rigs with a maximum of 1 per prospect. 1-2 resupply vessel trips per week per drilling rig during exploration drilling. 1-2 trips total per week (likely from Nikiski or Homer). 1-3 helicopter flights per day per drilling rig while on location. 7-21 trips total per week (helicopters likely traveling from Nikiski or Homer).
Government-initiated oil spill response exercises	2-5	Year-Round	1-3 exercises per year, each lasting no more than 1 day. Exercises could involve offshore and shoreline-based equipment deployment. Equipment could include containment boom, temporary storage devices (bladders towed in water or placed on the beach, fast tanks placed on the beach).	The number and types of transportation would vary dependent on the exercise. A likely scenario could include: Vessels (including OSRVs, M/Vs, Class 2, 3, 5, 6, and 8 vessels, containment barges, skiffs). Helicopters for personnel transport, area overflights. Fixed-wing aircraft for area overflights. Landing craft, all-terrain vehicles, and motor vehicles.

2.3.9 Summary of Acoustic Equipment

Marine seismic and geohazard surveys, as well as exploratory drilling, may involve a variety of active sources. Active systems are those that emit acoustic energy or sound into the water.

The active acoustic systems under the proposed action include devices for seismic reflection profiling, such as airgun arrays and subbottom profilers; sonar devices, such as echosounders, and sidescan sonar; and other acoustic sources, such as vessels and aircraft (Table 3). More information on the sound source verification measurements, source levels, and modeling assumptions are provided in the description of the proposed action (Section 2.3), and exposure analysis (Section 6.1.3).

Table 3. Primary acoustic sources that may be associated with the proposed action.

Active Acoustic Source	Frequency (kHz)	Approximate Broadband Source Level (dB re 1 µPa at 1m)
2400 in^3 marine seismic airgun array	<1	~238[1]
500 VSP in^3 airgun array (broadside)	<1	~228[2]
440 in^3 geohazard airgun array	<1	~225[1]

10 in^3 airgun survey (broadside)	<1	~206[1]
Bubble Pulser / Boomer	<1	~200[2]
Subbottom profiler	0.40-30	~230[2]
Side Scan Sonar	50-900	~230[2]
Single beam Echosounder	2-60	~200[2]
Multi beam Echosounder	180-240	~220[2]
Pinger	35-55	~197[2]
Impact Pile Driving	0.1-2	~190 @ 55m[3]
Tugs under Tow	<1	<200[4,5]
Vessel Noise Transit	<1	<200[2]
Drilling Operations	0.02-10	158[4]
Rotary Aircraft	<1	~162[2]

1 Sound source verification measurements for Apache 2012 seismic program in Cook Inlet (Austin and Warner 2012).

2 Lease Sale 244 Biological Assessment (BOEM 2017b).

3 Sound source verification measurements for impact hammer pile installation Southern Cross lease in Cook Inlet (Illingworth and Rodkin 2014)

4 Sound source verification measurements for *Randolph Yost* jack-up rig in Cook Inlet (Denes and Austin 2016a)

5 Furie exploration drilling program Biological Evaluation (Jacobs Engineering 2017).

2.3.10 Authorized Discharges

Based on the geologic analysis, exploration and delineation wells will average approximately 1,829 m (6,000 ft) in true vertical depth. The average exploration or delineation well will produce approximately 435 tons of mud and 747 tons of dry rock cuttings. Drilling wastes (muds and cuttings) will be likely be disposed of at the 7 to 10 exploration and delineation well sites that are scattered throughout the proposed Lease Sale Area (BOEM 2017b).

Well operations use a variety of drilling fluids, each with a different composition. While components vary, they may include a number of compounds in varying proportions (Table 4). The type of drilling fluids used depends on availability, the geologic conditions, and experiences of the drilling contractor. Often, several different types of drilling fluids are used in a single well and most (80%) of the drilling fluids are recycled. Discharged drilling fluids used for drilling the shallowest part of the well are typically a common water-base mud of the generic composition shown below. Fluid discharges are regulated by federal and state agencies.

Table 4. Composition of typical drilling fluids (based on U.S. Environmental Protection Agency (EPA), Type 2, Lignosulfonate Mud) (BOEM 2017b).

Drilling Fluid Components	
Bentonite	Barite
Lignosulfonate	Drilled solids
Lignite	Soda ash/Sodium
Caustic	bicarbonate
Lime	Cellulose Polymer
	Seawater/Freshwater

Not including drilling discharges, the major waste discharges produced during the first incremental step include bilge water, ballast water, fire control system test water, cooling water, sanitary and domestic wastes, and deck drainage (BOEM 2012a). Other discharges that could occur during exploration drilling include desalination unit discharges, BOP fluids, boiler blowdown discharges, excess cement slurry, several fluids used in subsea production, and uncontaminated freshwater and saltwater (BOEM 2012a).

Discharges from exploration operations in Cook Inlet are regulated under National Pollutant Discharge Elimination System (NPDES) General Permits issued by the USEPA, with a term of five years. The NPDES General Permit (AKG 28-5100) for exploration facilities was issued in July 2015 with an effective date of September 1, 2016 (EPA 2015a). The permit authorizes discharges from exploration facilities throughout most of the proposed Lease Sale Area, with the exception of 17 whole or partial OCS blocks (8.3% of the proposed Lease Sale Area) in the Kamishak Bay area west of a line from Cape Douglas to Chinitna Point, and one additional OCS block within 4,000 m (13,123 ft) of the Port Graham/Nanwalek Area Meriting Special Attention (AMSA) near the lower Kenai Peninsula (BOEM 2017b).

2.3.11 Accidental Oil Spills or Gas Release

Accidental gas releases or oil spills are illegal, unplanned accidental events and are not part of the first incremental step. Some small spills may be reasonably foreseeable during the first incremental step, but large and very large spills are not, and neither large nor very large spills are reasonably certain to occur during the first incremental step. BOEM and BSEE define small oil spills as <1,000 barrels (bbl). Large oil spills are defined as ≥1,000 bbl and very large oil spills (VLOS) are defined as ≥ 120,000 bbl. The analysis of potential oil spills during the first incremental step (years 1-5) is summarized in Table 5 and discussed below (BOEM 2017b).

Table 5. Cook Inlet Lease Sale 244 Action Area Oil Spill Estimates: First Incremental Step (BOEM 2016a, 2017b).

ESA Step	Phase	Exploration Activity	Source of Spill	Number of Spill(s)	Size of Spill(s) (in bbl)	Estimated Total Spill Volume	Frequency of Occurrence
First Incremental Step	Exploration	**Small Spills (Diesel and other Refined Products)**					
		Geological and Geophysical Activities[1]	Offshore	0-6	<1 or one up to13 bbl	0-<18 bbl	>99.5% chance of a small spill
		Exploration Drilling Activities	Offshore and/or Onshore Operational Spills from All Sources	0-4	5 bbl or one up to 50 bbl	0-65 bbl	
		Large Spills (Diesel or Crude)					
		Exploration Drilling Activities					Not estimated to occur
		Very Large Oil Spills (Crude)					
		Exploration Drilling Activities					Not estimated to occur ($>10^{-4}$ to $<10^{-5}$ per well)

Note: [1] 'Geological and Geophysical Activities' include marine seismic surveys, geohazard surveys, and geotechnical surveys.
Source: (BOEM 2016a), Appendix A, Table A.1-1 and Section A.1.2.3.

Small Oil Spills (<1,000 bbl)
Petroleum exploration activities have been conducted in State of Alaska onshore lands and waters adjacent to the Cook Inlet OCS since the 1960s. Small oil spills have occurred from State of Alaska or Pacific and Gulf of Mexico OCS oil and gas operations during exploration and are considered likely to occur during the first incremental step as well as subsequent stages. Spills during exploration activities are estimated to be small (50 bbl or less) and consist of refined oils because crude and/or condensate oil would not be produced during exploration (BOEM 2017a).

Refined oil is used in exploratory drilling activities for equipment and refueling. Any small refined oil spills during seismic and geophysical and geotechnical surveys and exploratory drilling activities are likely occur during April through early November.

Based on a review of potential discharges and on the historical oil spill occurrence data for the Alaska OCS, all the spills were small. From 1975 to 2015 industry drilled 85 exploration wells in the entire Alaska OCS (BOEM 2017a). During the time of this drilling, industry has had approximately 53 small spills totaling about 32 bbl or 1,344 gallons (gal). Of the 32 bbl spilled, approximately 24 bbl were recovered or cleaned up. Recovery in the early years of drilling often was not reported, and the field value in the database is often "unknown." Unknown values were treated as zero bbl recovered. In more recent spill records, recovery volume is an attribute that is regularly recorded (BOEM 2017a).

The estimated total numbers and volumes of small refined oil spills during first incremental step activities are presented in Table 5. BOEM and BSEE estimate that approximately 0-10 spills ranging in size from <1 bbl up to 50 bbl per spill could occur during the first incremental step (BOEM 2016a). G&G activities[6] may result in 0-6 spills in total (0-2 average annually), and exploration drilling may result in 0-4 small spills total (0-1 average annually) during the first incremental step. BOEM and BSEE estimate that most spills from the Proposed Action's G&G activities would be <1 bbl; one would be up to 13 bbl. Estimated total volume for G&G is 0-18 bbl (BOEM 2016a).

BOEM and BSEE estimate that most spills originating from the Proposed Action's exploration and delineation drilling activities would range up to 5 bbl, with one up to 50 bbl. Estimated total volume for exploration drilling spills is 0-65 bbl (BOEM 2016a). For the purpose of analysis, BOEM and BSEE assume a total of up to 83 bbl may be spilled during the first incremental step. Refined spills of the maximum assumed sizes (<13 bbl for G&G and <50 bbl for drilling) are anticipated to evaporate and disperse within 24 and 48 hours, respectively (BOEM 2016a).

Large Oil Spills (≥1,000 bbl)

BOEM and BSEE analyzed historical data on oil spills over the U.S. OCS from 1971 to 2014, and determined that no crude oil spills ≥1,000 bbl have occurred during exploration, other than the Deepwater Horizon (DWH) incident, which is considered a VLOS and described below. No large or very large oil spills have occurred historically in the Alaska OCS (BOEM 2017b).

BOEM and BSEE estimate that no large spills (≥1,000 bbl) would occur during the first incremental step of the Proposed Action (Table 5). The 22% probability of a large spill occurring (Table 7) refers to BOEM's estimate of the probability of a large spill occurring at any time during the entire life of the project, including exploration, development, production, and decommissioning. Table 7 also refers to BOEM's estimate of 0.24 large spills occurring during the entire life of the project.

For purposes of the oil spill analyses no large crude or diesel oil spills are expected from exploration and delineation drilling activities. This is based on a review of potential discharges, historical oil spill and modeling data, and the likelihood of large oil spill occurrence. This estimate is based on:

- The fact that the mean large spill number for all 40 years of the entire E&D scenario activities is less than one (0.24) and the most likely number of large spills that will occur over the life of the Proposed Action is zero.
- The low rate of OCS exploratory drilling well-control incidents spilling crude oil per well drilled.
- The fact that, since 1971, one OCS crude oil spill (large/very large) has occurred during temporary abandonment (converting an exploration well to a development well) while more than 15,000 exploratory wells were drilled without incident.

[6] G&G activities include marine seismic surveys, geohazard surveys, and geotechnical surveys, which total 12 surveys during the First Incremental Step (BOEM 2017b). BOEM assumes all G&G activity may have an offshore fuel transfer. However, there is a low probability of spill occurring during fuel transfer (The Glosten Associates and ERC 2012).

- The low number (10) of exploration wells being drilled as a result of this proposed action.
- The fact that no crude or condensate oil would be produced from the exploration wells, and the wells would be permanently plugged and abandoned.
- The fact that no large spills occurred while drilling 85 exploration wells to depth in the Alaska OCS between 1975 and 2015.
- The fact that only a small fraction of spills (any size) are estimated during the relatively short (5 years) first incremental step, as compared to the total spill number for future incremental steps (which include 35 years of development, production, and decommissioning activities).

In addition, any authorized exploration drilling program as part of the proposed action will include an oil spill response plan and provide for oil spill cleanup vessels and equipment, which may be staged near the drilling area.

In light of the above, effects from a large spill (>1,000-120,000 bbl) during exploration (years 1-5) cannot be said to be reasonably foreseeable or reasonably certain to occur. Therefore, they are not considered a direct or indirect effect of the first incremental step under the ESA and are beyond the scope of the analysis here (BOEM 2017b).

Very Large Oil Spills (VLOS) (≥120,000 bbl)

The final category of oil spills considered by BOEM and BSEE is a VLOS, which is defined as spills ≥120,000 bbl, and is considered a low-probability, high-impact event under NEPA. In other words, spills of this volume are highly unlikely to occur during any activities phase, but if one did occur, the impacts would be substantial (BOEM 2017b). The Exxon Valdez oil spill and the DWH oil spill are events that fall within the category of VLOS. The DWH VLOS occurred during exploration drilling, while the Exxon Valdez oil spill occurred in transit during the production phase.

It is possible, but highly unlikely, that a VLOS could occur from a well control incident followed by a long duration flow during exploratory drilling in the first incremental step, and drilling for production in a future incremental step. A VLOS is extremely unlikely to occur because the frequency of such a spill from a loss of well control (LOWC) incident is very low, and the number of wells anticipated to be drilled during the first incremental step is low (between 10^{-4} and 10^{-5} per well) (Table 7).

Thus, while the potential effects of a VLOS would be substantial if one were to occur, and such effects were analyzed in the Final EIS for the purpose of evaluating a low-probability, high impact event, the effects of a VLOS cannot be said to be reasonably foreseeable or reasonably certain to occur. Therefore, they are not considered a direct or indirect effect of the first incremental step under the ESA and are beyond the scope of the analysis here (BOEM 2017b). However, additional analysis is provided under Future Incremental Steps (Section 2.4.4).

Details concerning the estimated frequency of a VLOS event occurring as a result of the Proposed Action are provided in Appendix A, Section A-7 and Appendix B of the Final EIS (BOEM 2016a).

2.4 Future Incremental Steps

As described previously, future incremental steps include all activities that would occur after exploration and delineation and the approval of a DPP. A lessee must submit a detailed DPP per 30 CFR Part 550 (30 CFR §§550.241-550.262) that BOEM must review under NEPA. Development, production, and decommissioning activities will also require ESA section 7 consultations. Table 6 details the activities anticipated during future incremental steps, including associated transportation.

While the proposed action is focused on exploration activities, this consultation also considers potential impacts through the endpoint of the action as described below in the hypothetical E&D Scenario, followed by the decommissioning of all of these activities (years 6-40) (Table 6).

Unlike other Alaska OCS planning areas, the Cook Inlet Planning Area has a nearby market for both oil and gas. Cook Inlet gas has become a valuable commodity to be used locally or potentially transported as liquefied natural gas (LNG). As a result, the current E&D Scenario does not defer gas sales until oil production is depleted. The existing natural gas distribution system in south-central Alaska could be extended to transport gas from the Cook Inlet OCS to the greater Anchorage and Kenai Peninsula areas (BOEM 2016a).

Under the E&D Scenario, field development would occur between years six and nine, after which production would take place until the 34th year for oil and 39th year for gas (Table 6). Decommissioning would commence after oil and gas reserves at a given platform are depleted, and income from production no longer pays operating expenses. To comply with BSEE regulations (30 CFR §250.1710—wells, 30 CFR §250.1716—wellheads/casings, and 30 CFR §250.1725—platforms and other facilities), lessees are required to remove all seafloor obstructions from their leases within one year of lease termination or relinquishment (30 CFR §§250.1740-250.1743). BOEM and BSEE estimate that decommissioning activities would begin in the 35th year and continue through the 40th year. [(BOEM 2016a), Table 6].

This schedule is ambitious; it assumes no regulatory or scheduling delays and assumes immediate movement from exploration to development. The assumptions help ensure the potential impacts of future incremental steps will not be underestimated. However, the development of a prospect in the leased area would be determined by the lessee and could be affected by any delay.

Table 6. Future Incremental Step Activities Estimated for the Cook Inlet Lease Sale 244 E&D Scenario (BOEM 2016a).

Activity	Year(s)	Activity Period	Estimated Operations	Associated Transportation
Development and Production				
Onshore oil pipeline installation	6	Year-Round	50 mi of oil pipeline from landfall to existing processing facility (likely between Nikiski and Homer). Longer distances may be required for rerouting.	5 terrestrial vehicles. No vessels or aircraft.
Onshore gas pipeline installation	6	Year-Round	50 mi of gas pipeline from landfall to existing processing facility (likely between Nikiski and Homer). Longer distances may be required for rerouting.	5 terrestrial vehicles. No vessels or aircraft.

Activity	Year(s)	Activity Period	Estimated Operations	Associated Transportation
Offshore oil pipelines installation	6-9	May-Sept	60-85 mi of oil pipelines from initial platform to landfall and between platforms (distance will vary within this range based on actual prospect locations). Where subsea soil conditions allow, pipelines will be trenched using a subsea trenching jet. If burial is not possible anchors may be used to support and stabilize the pipeline.	2 vessels. 2 terrestrial vehicles. No aircraft.
Offshore gas pipeline installation	6-9	May-Sept	60-115 mi of gas pipelines from initial platform to landfall and between platforms (distance will vary within this range based on actual prospect locations). Where subsea soil conditions allow, pipelines will be trenched using a subsea trenching jet. If burial is not possible anchors may be used to support and stabilize the pipeline.	Gas pipeline installation will utilize the same 2 vessels and 2 terrestrial vehicles as oil pipeline installation.
Platform installation	7-10	Year-Round	A total of 3 platforms, each with 24 well slots, would be installed.	1-3 supply vessel trips per platform per week. 3-9 supply vessel trips total per week. Vessels needed for platform installation would be dependent on the type of platform installed. Installation typically requires 2 barges with cranes for platform stabilization/positioning and hoisting of modules topside of the platform. Tug boats also could be used for stabilization & positioning depending on structure type. Helicopters - 1-3 flights per platform per day. 21-63 flights total per week.
Drill production and service wells	7-13	Year-Round	A total of 55 to 76[1] production and service wells would be drilled at a maximum rate of 6 wells per platform per year.[2] Service wells would make up 15 to 23 percent of wells (i.e., 10 to 12 service wells are anticipated). During production/service drilling both drilling fluids and cuttings will be disposed of in service wells and/or barged to shore.	1-3 flights per platform per day. 21-63 flights total per week. 1-2 vessel trips per platform per week. 3-6 vessel trips total per week. 1-2 barge trips per platform per week for disposal. A maximum of 5-6 trips per week would be possible during the brief period when all 3 platforms could be drilling production and service wells, however, the number of barge trips generally would be <5-6 per week.
Oil production	7-34	Year-Round		1-3 flights per platform per day. 21-63 flights total per week. 1-2 vessel trips per platform per week. 3-6 vessel trips total per week.
Gas production	7-39	Year-Round		Transportation is included in "oil production," above. Transportation for gas production would continue at the same levels for years 35-39 (i.e., after the end of oil production is anticipated).
Government-initiated oil spill response exercises	7-39	Year-Round	1 exercise per operator every 1-3 years, each lasting no more than 1 day. Exercises could involve offshore and shoreline-based equipment deployment. Equipment could include containment boom, temporary storage devices (bladders towed in water or placed on the beach, fast tanks placed on the beach).	The number and types of vessels, aircraft, and onshore transportation would vary dependent upon the exercise. A likely scenario could include: Up to 30 vessels (including OSRVs, M/V, Class 2, 3, 5, 6, and 8 vessels, containment barges, skiffs). Helicopters for BSEE personnel transport, area overflights. Fixed-wing aircraft for area overflights. Landing craft, all-terrain vehicles, and motor vehicles for personnel transport.

Activity	Year(s)	Activity Period	Estimated Operations	Associated Transportation
Decommissioning				
Decommis-sioning	35-40	Year-Round	When income from production no longer pays operating expenses, the operator will begin to shut down facilities. Typical decommissioning includes the following: Wells will be permanently plugged with cement. Wellhead equipment will be removed. Processing modules will be removed from platforms. Subsea pipelines will be cleaned, plugged at both ends, and left buried in the seabed. Platforms will be disassembled and removed from the area. Seafloor will be restored to pre-activity conditions.	The number and types of vessels, aircraft, and onshore transportation would vary dependent upon the decommissioning activities. Use of vessels, including barges with cranes and tugs for platform removal, is anticipated. Terrestrial transportation and equipment for onshore decommissioning would be similar to that used during installation. Aircraft and terrestrial transportation to support decommissioning efforts and possible post-decommissioning surveys likely would occur.

[1]Although BOEM (2016a) provides a tabular value of up to 66 production and service wells, elsewhere in the document (e.g., page 4-8) the value of 76 is used as the upper estimate for well numbers. We therefore assume that a maximum of 76 production and service wells may be drilled.
[2]Service wells are used for disposal of drilling fluid and cuttings.

Timing

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

1. There is a 3-year environmental analysis process between delineation and development for proposed developments.
2. Due to the inability to predict accurately which issues may be litigated or how long the process could take, there are no delays for litigation in the schedule.
3. It will take 4 years to install production platforms. A maximum of six wells per platform may be drilled per year, for a total of 24 potential wells per platform. The timing of well drilling determines the production schedule.

The real driver of the timeline is the time needed to install platforms and drill their associated wells after a discovery is made. Each platform is installed, commissioned, and producing in its first year, with up to six wells drilled in that first year and the remainder drilled in subsequent years. The oil and gas fields may be physically overlain, but the scenario depicted assumes no wells or facilities could be shared. If the oil and gas fields overlap, wells from the platforms could be completed in both oil and gas zones, reducing the overall number of platforms and the number of wells (BOEM 2017b).

2.4.1 Development Activities

After an operator commits to develop a prospect, project designs will be evaluated and the operator will make development decisions based on, among other things, experience, expectations, and availability of equipment and personnel. The DPP is likely to undergo revision during the development phase as the operator incorporates lessons learned and understanding of the reservoirs gained through drilling and production. Development activities include installing production platforms and pipelines, drilling production wells, and installing tie-ins to existing shore-based infrastructure (Figure 2).

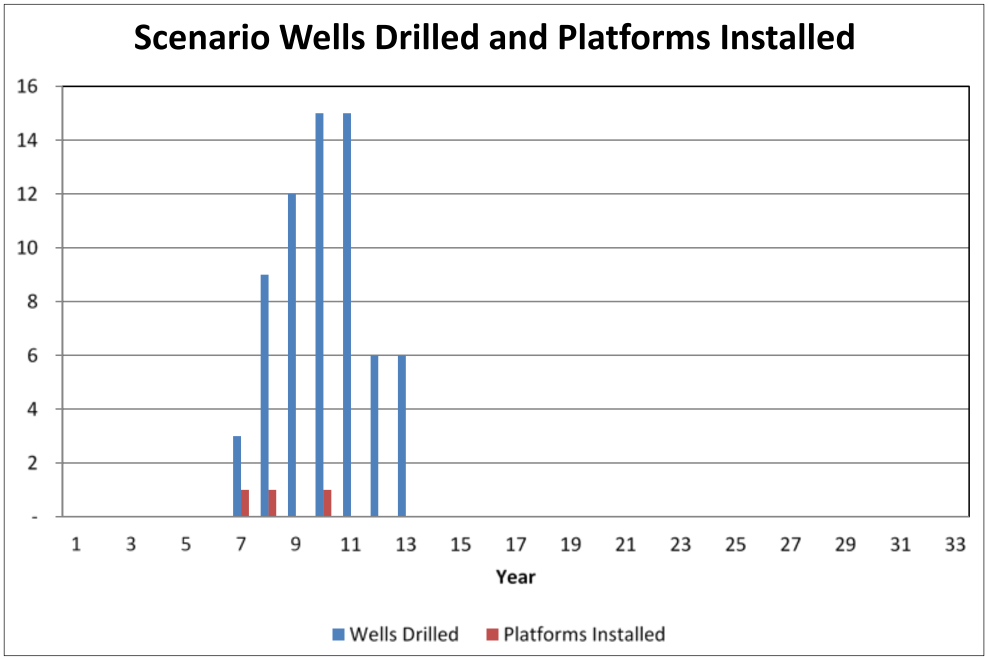

Figure 2. Production and Service Well Drilling and Platform Installation (BOEM 2017b).

Pipelines

In the E&D Scenario, development would begin in the 6th year with the installation of oil and gas pipelines (on- and off-shore). Pipeline installation is expected to continue through the 9th year (Table 6). Construction of the pipelines is anticipated to occur between the beginning of May and the end of September. Unlike other Alaska OCS Planning Areas, the Cook Inlet region has existing onshore oil and gas infrastructure. We assume that existing onshore facilities (e.g., Nikiski) and nearby ports (e.g., Homer, Port Graham) will be used as shore bases.

The preferred method to transport oil and gas from the initial platform would be via subsea pipelines from the initial platform to the nearest landfall location, probably on the Kenai Peninsula between Homer and Nikiski, depending upon where the first commercial oil discovery is located. The second and third platforms would have pipelines linking them to the initial platform. Offshore oil and gas pipelines are estimated to be 60-85 mi and 60-115 mi in length, respectively, although the actual distance is expected to vary within this range based on actual prospect locations[7]. Based upon the distance from pipelines already in place in upper Cook Inlet, it is not anticipated that any of the production platforms from new discoveries in the LS 244 area in the lower Cook Inlet will be able to utilize any existing pipelines.

[7] The maximum estimated offshore gas pipeline length differs from the maximum extent estimated for the offshore oil pipelines because the E&D Scenario considers the possible development of a gas-only field that is farther from the potential shorebased locations (BOEM 2017b).

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

Seafloor disturbance as a result of pipeline construction, trenching, or associated anchors would depend on the final length of the pipelines and whether trenching occurs. It is estimated that placement disturbs between 0.5 and 1 ha (1.25 and 2.5 ac) of seafloor per kilometer of pipeline (for both oil and gas), with the uncertainty depending on whether trenching is required (Cranswick 2001). BOEM estimated that the total length of the offshore oil pipelines will range 96 to 137 km (60 to 85 mi), and the total length of the offshore gas pipelines will range from 96 to 185 km (60 to 115 mi), depending on the actual platform and landfall locations. For the total potential pipeline length of 322 km (200 mi), it is estimated that 161 to 322 ha (398 to 796 ac) of seafloor could be disturbed, depending on the amount of trenched and buried pipe (BOEM 2017b).

Production Platforms

In the E&D Scenario platform installation would commence in the 7th year (Table 6). Two to three platforms would be installed over the course of four years. Water depth, sea conditions, and ice conditions are important factors in selecting a platform type. The existing platforms in Cook Inlet located in state waters were constructed onshore, floated to the targeted location, and installed. In the E&D Scenario it is assumed that each production platform will be a steel-caisson platform constructed and designed to be tide and ice resistant. It is assumed that installation activities could occur year-round. Each of the three platforms in the Scenario would house production and service (injection) wells, processing equipment, fuel, and quarters for personnel. The first platform would serve as a hub, connecting pipelines from other platforms to the main pipelines to shore. Total area of sediment disturbed by use of a steel-caisson platform will depend on platform design. The 2012 Leasing Programmatic EIS estimates each production platform will disturb approximately 1.5 ha (3.7 ac) of seafloor (BOEM 2012a). If three platforms are installed, disturbance totals 4.5 ha (11.1 ac) of seafloor.

Production and Service Wells

Due to the extreme tides and seasonal ice conditions in Cook Inlet, there are no subsea wells (wells that reach the seafloor via a seafloor template at distance from the platform) included in the E&D Scenario (i.e., all wells reach the surface at a production platform). Each platform would contain up to 24 well slots. A maximum of six wells per year per platform may be drilled. Production and service well drilling is expected to begin in the 7th year and continue through the 13th year (Table 6). A total of 55 to 76 production wells would be drilled. Ten to 12 of these (15-23 percent) would be service wells. No additional area of surface disturbance from drilling multiple development wells from production platforms is expected.

Authorized Discharges

If a discovery is made, development wells might average 2,286 m (7,500 ft) in measured depth. Most development wells are drilled at an angle, rather than straight down, making the drilled distance of a typical development well longer than an exploration well drilled to the same formation. Drilling of development wells will be similar to drilling of exploration and delineation wells except that synthetic-based fluid and Synthetic-based-fluid-wetted cuttings from development wells cannot be discharged overboard and instead will be shipped to shore for disposal or reinjected into approved disposal wells. BOEM estimates the average development well will produce approximately 839 tons of dry rock cuttings. Cuttings will be either ground and injected or barged to an onshore disposal site. No drilling fluids or cuttings will be discharged at production well sites.

Discharges from development operations in Cook Inlet are regulated under NPDES General Permits issued by USEPA, with a term of five years. The most recent General Permit (AKG 28-5100) for Cook Inlet OCS development and production facilities was effective on September 1, 2016 (80 FR 46575) and expires on August 31, 2021. BOEM and BSEE assume that a new general permit will be in place before any activities under E&D Scenario that are scheduled after August 31, 2021 are initiated. Discharges authorized under the General Permit include sanitary waste, domestic waste, deck drainage, desalination unit waste, cooling water, ballast and bilge water, and other miscellaneous effluents. Disposal wells would handle waste water from the crew quarters and mess facilities on the platforms. Other solid waste would be barged to an onshore treatment and disposal facility (BOEM 2017b).

Transportation

Helicopters and supply vessels from existing facilities located in either Homer or Nikiski would support OCS construction (i.e., platform and pipeline installation) and development drilling operations. Helicopters would probably fly at a frequency of one to three flights per platform per day during development operations. Support-vessel traffic is estimated to consist of one to three trips per platform per week (Table 6).

Pipeline installation would occur between May and September during years six through nine (Table 6). Both oil and gas pipelines would be installed simultaneously. Two vessels, a laying vessel and a trenching vessel, would likely be used for installation.

Platform installation would occur year-round during years seven through 10 (Table 6). Transport and placement of platforms likely would require the short-term use of vessels for transport and placement. The types of vessels needed would be dependent on the type of platform chosen. Installations typically require two barges with cranes and one or more tugs to help tow, position, and stabilize platforms and to hoist modules topside.

During the drilling of production and service wells, drilling fluid and cuttings may be disposed of in service wells and/or barged to shore for disposal. Transportation of cuttings for onshore disposal is estimated to require 1 to 2 barge trips per platform per week during drilling operations. A maximum of 5 to 6 trips per week would be possible during the brief period when all 3 platforms could be drilling production and service wells; however, the number of barge trips generally would be <5 to 6 per week (Table 6).

During future incremental steps, government-initiated oil spill response exercises would occur every 1-3 years. The numbers and types of transportation used during government-initiated oil spill response exercises would vary dependent on the exercise but would likely include vessels (e.g., OSRVs, M/Vs, containment barges, skiffs), helicopters, fixed-wing aircraft, and terrestrial transportation (Table 6) (BOEM 2017b).

2.4.2 Production Activities

Oil production would commence with the drilling of the first platform production well and ramp up as more wells are drilled. In the E&D Scenario, oil and gas production would probably begin in the 7th year (Table 6), and production would continue year round. In Cook Inlet the associated gas produced with the oil can be sold to the local natural gas distribution system. Oil production would continue through the 34th year and gas production would continue through the 39th year. Figure 3 shows the forecasted yearly oil and gas production (BOEM 2017b).

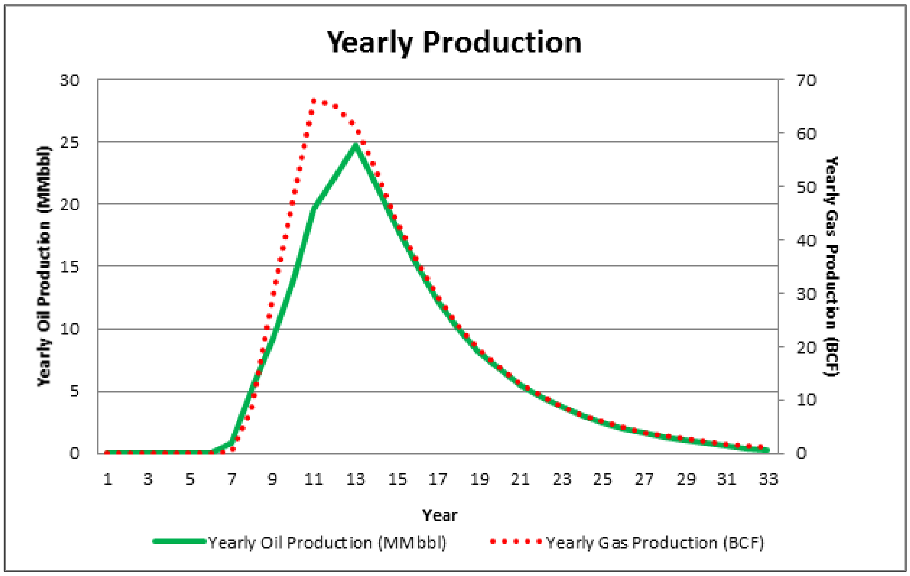

Figure 3. E&D Scenario Forecast Oil and Gas Production (BOEM 2017b).

Production operations would largely involve resupply of materials and personnel, inspection of various systems, and maintenance and repair.

Maintenance

After the OCS infrastructure construction is complete, operations largely will involve resupply of supplies and personnel, inspection of various systems, maintenance, and repair. Maintenance and repair work will be required on the platforms, and processing equipment will be upgraded to remove bottlenecks in production systems. Well repair work will be required to keep both production and service wells operational (BOEM 2017b). Pipelines will be inspected and cleaned regularly by internal devices (e.g., pipeline inspection gauges or "pigs"). Crews will be rotated at regular intervals.

Authorized Discharges

Discharges from production operations in Cook Inlet are regulated under NPDES General Permits issued by USEPA, with a term of five years. Discharges from development operations in Cook Inlet are regulated under NPDES General Permits issued by USEPA, with a term of five years. The most recent General Permit (AKG 28-5100) for Cook Inlet OCS development and production facilities was effective on September 1, 2016 (80 FR 46575) and expires on August

31, 2021. BOEM and BSEE assume that a new general permit will be in place before any activities under production are initiated. Discharges authorized under the General Permit include sanitary waste, domestic waste, deck drainage, desalination unit waste, cooling water, ballast and bilge water, and other miscellaneous effluents.

Production fluids (oil, gas, and water) would be gathered on the platforms where gas and produced water would be separated, and gas and water reinjected into the reservoir using service wells. During the later gas sales phase, only water would continue to be reinjected. Disposal wells would handle wastewater from the crew quarters on the platforms (BOEM 2017b).

Transportation

During normal production operations, the frequency of helicopter flights offshore would remain the same as during development (1 to 3 per platform per day), but marine traffic would drop to about one to two trips per week to each platform. Marine traffic would occur year round since this area remains ice free during the winter. If barges are used to transport the drill cuttings and spent mud from production wells during drilling operations, a dedicated barge could make 1 to 2 trips per platform per week to an onshore disposal facility (BOEM 2017b).

2.4.3 Decommissioning Activities

Decommissioning activities may begin in the 35th year (Table 6). After oil and gas resources are depleted and income from production no longer pays operating expenses, the operator will begin to shut down facilities. In a typical situation, wells will be permanently plugged with cement and wellhead equipment removed. Processing modules will be moved off the platforms. It is not expected that pipelines will be removed at the end of their serviceable life; rather, they will be decommissioned, cleaned, and left buried in sediment. This practice prevents the additional disturbance to sediments and benthic communities which would occur if pipelines were removed. Subsea pipelines will be decommissioned by cleaning the pipelines, plugging both ends of individual pipelines, abandoning them in place. Lastly, the platform will be disassembled and removed from the area, and the seafloor site will be restored to some practicable predevelopment condition. Cutters are typically used to remove platform legs. Post decommissioning surveys would be required to confirm that no debris remains and pipelines were decommissioned properly (BOEM 2017b).

Authorized Discharges

As with discharges from other future incremental steps, discharges from decommissioning activities would be regulated under NPDES permits. Discharges authorized under the General Permit include sanitary waste, domestic waste, deck drainage, desalination unit waste, cooling water, ballast and bilge water, and other miscellaneous effluents (BOEM 2017b).

Transportation

The number and types of vessels, aircraft, and onshore transportation would vary dependent upon the decommissioning activities. Use of vessels, including barges with cranes and tugs for platform removal, is anticipated. Terrestrial transportation and equipment for onshore decommissioning would be similar to that used during installation. Aircraft and terrestrial transportation to support decommissioning efforts and possible post-decommissioning surveys likely would occur (Table 6).

2.4.4 Accidental Oil Spills or Gas Release

BOEM and BSEE’s estimate of the chance of spills occurring assumes that the exploration and development activities described in the E&D Scenario will occur and 215 million barrels (Mmbbl) of crude oil, natural gas liquid condensate, and natural gas will be produced. For the purposes of analysis under future incremental steps, BOEM and BSEE estimate that approximately 450 small spills (<1,000 bbl) could occur (Years 6-40). BOEM and BSEE also estimate the mean number of large (≥ 1,000 bbl) spills is less than one (0.24, rounded up to 1 for the purposes of oil spill analyses) and the most likely number of very large spills over the development, production, and decommissioning life of the Proposed Action approaches zero (Table 7) (BOEM 2017b).

Table 7. Cook Inlet Lease Sale 244 Action Area Oil Spill Estimates: Future Incremental Step (BOEM 2017b).

ESA Step	Phase	Activity	Source of Spill	Number of Spill(s)[1]		Size of Spill(s) (in bbl)	Estimated Total Spill Volume	Frequency of Occurrence
Future Incremental Steps	Development, Production and Decommissioning	**Small Spills (Crude, Condensate, or Diesel and other Refined Products)**						
		Development Plan Activities (Development, Production, Decommissioning)	Offshore and/or Onshore Operational Spills from All Sources	~450[1] Total			~300[1] bbl	>99.5% of a small spill
				<1 bbl	432[1]	3 gallons	10 bbl	
				1-<50 bbl	16	3 bbl	48 bbl	
				50-<500 bbl	2	126 bbl	252 bbl	
				500-<1,000 bbl	0	0 bbl	0 bbl	
		Large Spill or Gas Release (Crude, Condensate, Diesel or Refined, or Natural Gas)						
		Development Plan Activities (Production)	Onshore Pipeline, or Offshore Pipeline, or Offshore Platform/ Storage Tank/Well	0.24 Total NEPA and Biological Assessment analysis assumes up to 1 from either		2,500 bbl, or 1,700 bbl, or 5,100 bbl	2,500 bbl, or 1,700 bbl, or 5,100 bbl	78%[2] chance of no large spills occurring; 22% chance of one or more large spills over the entire life.
			Offshore Platform/Well	1 gas release		8 million ft^3	8 million ft^3	3.6 $x10^{-4}$ per well
		Very Large Oil Spills (Crude)						
		Development Plan Activities						Not estimated to occur $>10^{-4}$ to $<10^{-5}$

Note: [1]These numbers have been rounded. [2] Estimated from a mean large spill number of 0.243.

Small Spills (<1,000 bbl)

Small spills of both refined oils and crude and/or condensate oils could occur both onshore and offshore during future incremental steps. The estimated total numbers and volumes of small oil spills resulting from future incremental step activities are presented in Table 7. BOEM and BSEE estimate that approximately 450 spills of refined oil and crude or condensate oil could occur during future incremental steps. BOEM and BSEE estimate that the majority of these spills would be 3 gallons on average. BOEM and BSEE estimate 16 spills of 1 to <50 bbl, and up to two spills of 50 to <500 bbl, could occur (BOEM 2017b).

Large Spills (≥1,000 bbl) or Gas Releases

A large spill is a statistically unlikely event. OCS large spill rates are the mean number of large spills per billion barrels of hydrocarbon produced or transported (BOEM 2016a). BOEM and BSEE assume that 215 Mmbbl of oil would be produced and transported by pipeline, resulting in an estimate that less than one (0.24) large spill would occur over the life of the proposed action. Additionally, based on the mean number of large spills, BOEM and BSEE estimate that the probability of one or more large platform/pipeline spills occurring during all incremental steps is 22 percent. Consequently, for purposes of conducting a large spill analysis, BOEM assumes the occurrence of one large spill, and conducts a large oil spill analysis for the future development and production activities accordingly. This analysis addresses whether such spills could cause serious environmental harm, and informs decision-makers of potential impacts of a large spill. Overestimating the projected number of large spills or gas releases helps to ensure that this BA does not underestimate potential environmental effects.

BOEM's analysis assumes that the size of the large spill is 1,700 bbl for an OCS pipeline spill, 2,500 bbl for an onshore pipeline spill, and 5,100 bbl for an OCS platform spill. In the oil-spill analysis, BOEM and BSEE first discussed the conditional probabilities of a large spill contacting specific protected resource Environmental Resource Areas (ERAs), where an ERA is a polygon representing an area of social, economic, or biological resources, or resource habitat area (BOEM 2016a). Combined probabilities differ from conditional probabilities in that they do not assume that a large spill has occurred and consolidate non-uniform weighting of launch area (LA) probabilities into one unit probability. The chance of one or more large oil spills occurring is multiplied by the area-wide chance that a large oil spill would contact a particular ERA to estimate a combined probability of the occurrence of a large spill that subsequently contacts ERAs.

To estimate the effects of a large oil spill resulting from the Proposed Action, BOEM and BSEE estimated information regarding the general source(s) of a large oil spill (such as a pipeline, platform, or well) or gas release, the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. Collectively, this information provides an oil-spill scenario. BOEM and BSEE also estimated the mean number of large spills and the chance of one or more large spills or a gas release occurring over the life of the Proposed Action.

The large spill-size assumptions BOEM and BSEE used are based on the reported spills in the Gulf of Mexico and Pacific OCS because no large spills have occurred on the Alaska or Atlantic OCS from oil and gas activities. BOEM used the median OCS spill size as the likely large spill size (Anderson et al. 2012a) because it is the most probable size for that spill size category. The Gulf of Mexico and Pacific OCS data suggest that a large spill would most likely originate from a pipeline or platform. The median size of a crude oil spill ≥1,000 bbl from a pipeline on the OCS over the last 15 years is 1,720 bbl, and the average is 2,771 bbl (Anderson et al. 2012a) (Table 8). The median spill size for a platform on the OCS over the entire record from 1964 to 2010 is 5,066 bbl, and the average is 395,500 bbl (Anderson et al. 2012a). The U.S. Department of Transportation, U.S. Department of Transportation, Pipeline & Hazardous Materials Safety Administration (USDOT, PHMSA), Office of Pipeline Safety Research and Special Programs Administration keeps information about distribution and transmission pipeline accident and incident data online (USDOT PHMSA 2015b, c, a). This information was used to estimate onshore pipeline median spill size. For purposes of analysis, BOEM and BSEE used the median spill size, rounded to the nearest hundred shown below, as the likely large spill sizes.

Table 8. Large Spill Sizes from Anderson et al. (2012) and BOEM (2017b).

	OCS Pipeline	OCS Platform	Onshore Pipeline
Median large spill size (bbl)[1]	1,720	5,066	---
Mean large spill size (bbl)[1]	2,771	395,500	---
Assumed large spill size (bbl)[2]	1,700	5,100	2,500

Very Large Oil Spills (≥120,000 bbl)

BOEM and BSEE analyzed the potential impacts of a VLOS (a spill of ≥120,000 bbl) scenario in Chapter 4.12 of the Draft EIS for the purposes of evaluating a low-probability, high-impact event under NEPA. VLOS are analyzed separately from large oil spills due to their lower level of probability. Because a VLOS is a highly unlikely event, and is not reasonably foreseeable or reasonably certain to occur, it is not considered for the purposes of this BA to be an impact producing factor of the Proposed Action. Details concerning the estimated frequency of a VLOS event occurring as a result of the Proposed Action are provided in Appendix A, Section A-7 of the FEIS (BOEM 2016a).

2.5 Mitigation Measures

BOEM is proposing measures to minimize potential adverse effects to listed species from activities associated with the proposed action. These measures include: lease stipulations; information to lessees (ITL), notice to lessees (NTL), vessel speed restrictions, and marine trash and debris awareness briefings. Unless otherwise noted in this biological opinion, NMFS considers these mitigation measures to be part of the description of the action.

2.5.1 Lease Stipulations

Lease Stipulations are binding contractual provisions that apply to all Ancillary Activities, EPs, DPPs, and Development Operations Coordination Documents (30 CFR §550.202). Lease Sale Stipulations often consist of protective measures designed to decrease the likelihood of impacts to environmental resources such as marine mammals. The Lease Stipulations are part of the Proposed Notice of Sale package for Lease Seale 244. A brief summary of those Lease Stipulations that may serve to reduce impacts to marine mammals is provided below. Further description can be found at https://www.boem.gov/Sale-244-Stipulations/.

- Stipulation No. 1 – Protection of Fisheries*
- Stipulation No. 2 – Protection of Biological Resources*
- Stipulation No. 3 – Orientation Program*
- Stipulation No. 4 – Transportation of Hydrocarbons*
- Stipulation No. 5 – Protection of Beluga Whale Critical Habitat
- Stipulation No. 6 – Protection of Beluga Whale Nearshore Feeding Areas

- Stipulation No. 7 – Protection of Beluga Whales
- Stipulation No. 8 – Protection of Northern Sea Otter Critical Habitat
- Stipulation No. 9 – Protection of Gillnet Fishery
- Stipulation No. 10 – Prohibition of Drilling Discharges

*Stipulations applicable to LS 244 leases provided in Appendix A of BOEM's Final Biological Assessment and FEIS (BOEM 2016a, 2017b). Stipulations 5-10 can be found in the Lease Stipulations for the Final Notice to of Sale for LS 244.

The lease stipulations that have the most impact on NMFS' trust resources, including endangered or threatened species and their critical habitat, are stipulations 2, 5, 6, 7, and 10. Lease stipulation 2 is intended to protect biological resources that are discovered during the course of operations. If previously unidentified biological populations or habitats that may require additional protection – for example, marine mammal haul out areas – are identified in the lease area, the lessee may be required to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The lessee may also be required to do one or more of the following: relocate the site of operations; establish that its operations will not have a significant adverse effect upon the resource identified, or that a special biological community does not exist; operate during those periods of time 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. Stipulations 5-7 are intended to protect endangered Cook Inlet beluga whales and their habitat, by prohibiting activity during feeding and when it is likely that beluga whales are in specific areas. The date ranges of these exclusions are between July and September, and November and April (see Table 2 for additional information).

2.5.2 Information to Lessees and Operators

BOEM's Information to Lessee (ITLs) provide information about issues and concerns related to particular environmental or sociocultural resources, provide guidance on how lessees might plan their activities to meet BOEM requirements, or reduce potential impacts. Other ITLs provide information about the requirements or mitigation measures imposed by other federal and state agencies. ITLs are effective in lowering potential impacts by alerting and informing lessees and their contractors about possible mitigation measures. The ITLs listed below apply to all OCS activities in Cook Inlet conducted pursuant to LS 244 leases and are considered part of the Proposed Action. Applicable ITLs are available at https://www.boem.gov/Sale-244-ITLs/.

(1) Bird and Marine Mammal Protection*
(2) Endangered and Threatened Species Protection*
(3) Seismic Surveys: Environmental and Regulatory Review and Coordination Requirements*
(4) Archaeological and Geological Hazards Reports and Surveys*
(5) Sensitive Areas to be Considered in Oil Spill Response Plans*
(6) Discharge Restrictions and Prohibitions*
(7) Trash and Debris Awareness and Elimination*
(8) Air Quality Regulations and Standards
(9) Navigation Safety
(10) Notice of Arrival on the Outer Continental Shelf

(11) Bidder/Lessee Notice of Obligations Related to Criminal/Civil Charges and Offenses, Suspension, or Debarment; Disqualification Due to a Conviction under the Clean Air Act or the Clean Water Act
(12) Oil Spill Response Preparedness
(13) Offshore Pipelines
(14) BSEE Inspection and Enforcement of Certain Coast Guard (USCG) Regulations

The Final EIS identifies seven Information to Lessees and Operators (ITLs) to be included in the Proposed Action that are most likely to be protective of resources under NMFS jurisdiction (BOEM 2016a). The key features of these ITLs are summarized below; the full wording is provided in Appendix A of the Revised Biological Opinion (BOEM 2016a). These ITLs may help to reduce impacts on endangered or threatened species and critical habitat by providing information and situational awareness to lessees and operators. However, because ITLs provide for lessees summaries on legal requirements under the applicable laws and regulations but do not themselves impose enforceable requirements, they are not considered in the analysis of effects in this opinion. The additional listed ITLs are not likely to measurably reduce direct impacts on the listed species within this consultation.

- ITL No. 1 – Bird and Mammal Protection. This ITL informs lessees and operators that all of its agents, contractors, and subcontractors are subject to the provisions of the ESA, Marine Mammal Protection Act (MMPA), Migratory Bird Treaty Act (MBTA), and Bald and Golden Eagle Protection Act (BGEPA). It advises lessees and operators to avoid disturbing marine mammals and birds.
- ITL No. 2 – Endangered and Threatened Species. This ITL identifies the ESA-listed endangered or threatened species that may be present in Cook Inlet. It advises lessees and operators that BOEM will perform an environmental review for each proposed EP and DPP, including an assessment of direct, indirect, and cumulative effects on endangered and threatened species. It states that NMFS and USFWS will review EPs and DPPs to ensure that threatened and endangered species are protected. Lessees are advised to contact NMFS and USFWS regarding proposed operations and actions that might be taken to minimize interaction with these species.
- ITL No. 3 – Seismic Surveys: Environmental and Regulatory Review and Coordination Requirements. This ITL advises lessees and operators that seismic surveys could affect northern sea otters, beluga whales, other marine mammals, and coastal birds. It also advises lessees and operators that all seismic surveys conducted in the Cook Inlet Planning Area as an ancillary activity in support of an EP or DPP is subject to environmental and regulatory review by BOEM and that protective measures may be developed based on consultations with NMFS and USFWS.
- ITL No. 4 – Archaeological and Geological Hazards Reports and Surveys. This ITL advises lessees and operators that regulations at 30 CFR §550.214(e) and 30 CFR §550.244(e) require a shallow hazards report to be included with all EPs and DPPs submitted to BOEM for completeness review. In addition, BOEM may require lessees to include an archaeological resources report as required by 30 CFR §550.227(b)(6) and 30 CFR §550.261(b)(6).
- ITL No. 5 – Sensitive Areas to be Considered in Oil Spill Response Plans. This ITL lists certain areas in Cook Inlet that are especially valuable for their concentrations of marine

birds, marine mammals, fish, other biological resources or cultural resources, and for their importance to subsistence harvest activities. Lessees are advised to consider these areas when developing their oil spill response plans (OSRPs). Areas identified in this ITL include critical habitat designed under the ESA.

- ITL No. 6 – Discharge Prohibition in Certain Areas. This ITL advises lessees and operators that the NPDES General Permit AKG-28-5100 issued by the USEPA prohibits all discharges from OCS oil and gas exploration facilities in Kamishak Bay west of a line from Cape Douglas to Chinitna Point (USEPA, 2015a). In addition, the NPDES General Permit AKG 31-5000 prohibits discharges from OCS oil and gas exploration facilities within 4,000 m (13,123 ft) of the Port Graham/Nanwalek AMSA near the lower Kenai Peninsula.
- ITL No. 7 – Trash and Debris Awareness and Elimination. This ITL informs lessees and operators that trash and debris pose a threat to marine mammals, birds, fish, and other wildlife. It identifies the relevant regulations governing waste disposal and advises lessees to exercise special caution when handling and disposing of small items and packaging materials, particularly those made of non-biodegradable, environmentally-persistent materials, such as plastic or glass.

2.5.3 Notice to Lessees

Notices to Lessees (NTL) are formal documents that provide clarification, description, or interpretation of a regulation or OCS standard; provide guidelines on the implementation of a special lease stipulation or regional requirement; provide a better understanding of the scope and meaning of a regulation by explaining BOEM’s interpretation of a regulatory requirement; or transmit administrative information. NTLs are either applicable nationally to the OCS program or are issued by and applicable to specific regions of the OCS. There are three NTLs specific to the BOEM or BSEE Alaska OCS Region (BOEM 2016a), which are summarized below. The National NTLs are posted to BOEM’s website at http://www.boem.gov/notices-to-lessees-and-operators.

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

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

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

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

- **NTL 2005-A03 –** Archaeological Survey and Evaluation for Exploration and Development Activities - Before a lessee/operator is allowed to commence drilling, facility construction, or pipeline rights of way activities, BOEM may require archaeological surveys and analysis to evaluate the location and condition of any submerged archaeological resources that could be affected by the proposed activities. An archaeological resource report analyzes geophysical survey data for indications of archaeological resources. When notified by the Regional Director (RD) that archaeological resources may exist in the lease area, the lessee/operator must perform an archaeological survey and an archaeological report must be included in the exploration or development plan or pipeline right-of-way application. When BOEM determines that the survey data and analysis indicate the potential for an archaeological site(s) to be affected, the lessee/operator must:

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

It provides guidance to lessees and operators conducting archaeological surveys before E&D activities. NTL 2005-A03 provides detailed guidance about the conduct of archaeological surveys, including requirements regarding survey design, seafloor imagery, bathymetry, acoustic subbottom profilers, magnetometers, navigation, shallow core data, and reporting (BOEM 2016a).

2.5.4 Mitigation Measures Associated with First Incremental Step Activities

Mitigation measures are specific to the different types of activities in each phase of oil and gas development. Below, with respect to exploration, mitigation measures and typical monitoring protocols for seismic operations are addressed first, and then mitigation measures associated with exploratory and delineation drilling are presented. Mitigation measures for vessel and aircraft activities are also presented. These mitigation measures are part of the proposed action and therefore their implementation is required.

If first incremental step activities delineate oil and gas reserves of sufficient size, and companies choose to move into production, additional consultation would take place when BOEM receives a DPP. The DPP describes development and production activities proposed by an operator for a lease or group of leases. The description includes the timing of these activities, information concerning drilling vessels, the location of each proposed well or production platform or other structure, and an analysis of both offshore and onshore impacts that may occur as a result of the plan's implementation. The DPP also would identify the precise location of the production well and associated facilities such as pipelines to shore and onshore processing facilities. The DPP therefore would provide BOEM, BSEE, and NMFS with project-specific details of future incremental step activities that will enable the agencies to evaluate impacts on listed species and critical habitat at a more detailed level and to identify potential mitigations of such impacts. Because project-specific details of future incremental step activities are not available at this time, mitigation measures for future incremental step activities are not included in this opinion.

The following mitigation measures apply to the first incremental step activities. The mitigation measures below are designed to minimize and avoid take during activities within the first incremental step. Failure to follow these mitigation measures may result in take that counts against the take levels authorized for a particular activity, if take is authorized in an incidental take statement following project-specific consultation on exploration activities. Such instances of take will be reported as indicated in these mitigation measures below. Additional mitigation measures may be necessary once project-specific details are developed and addressed in subsequent project-specific consultations.

2.5.4.1 Seismic Surveys

Seismic operations include deep penetration (primarily marine 2D and 3D surveys; see Section 2.3.2) and geohazard surveys (high-resolution surveys; see Section 2.3.4). Monitoring is conducted by on-board Protected Species Observers (PSOs) to implement appropriate mitigation measures to protect ESA-listed species during completion of specific activities.

The monitoring protocols below ensure that the following mitigation measures are implemented as appropriate. Mitigation measures vary with the specific category of seismic survey being conducted.

Vessel-based Seismic Surveys

BOEM’s proposed mitigation measures for vessel-based seismic surveys, during the first incremental step, include:

- *Timing and location*: Timing and locating survey activities to reduce the potential for disturbing marine mammals, protected species, and fisheries; e.g., restricting seismic activities to minimize adverse effects to beluga whales, their critical habitat, food sources, and the gill net fishery.
- *Minimized energy output*: Using the lowest sound levels practicable to achieve data collection requirements; accomplished by choosing and configuring the energy source array so that it decreases the amount of energy introduced into the marine environment.
- *Establish behavioral disturbance (Level B) and injurious zones (Level A) for marine mammal harassment:* Early season field assessment to establish and refine (as necessary) the appropriate Level A and Level B harassment zones for marine mammals (see below for more details).

The potential disturbance of marine mammals during seismic survey operations is minimized further through the typical implementation of several ship-based mitigation measures, which include establishing and monitoring Level A and Level B harassment zones; speed and course alterations; ramp-up (or soft start), power-down, and shutdown procedures; and provisions for poor visibility conditions. Furthermore, the Proposed Action also contains timing restrictions (Table 2), including seasonal and area restrictions on certain activities when beluga whales are more likely to be present in the action area, that restrict seismic activities to minimize adverse effects to beluga whales, their critical habitat and food source, and the gill net fishery (BOEM 2017b). The anticipated distances to Level B harassment zones is provided in Table 9**.**

The mitigation measures below are designed to minimize and avoid take during activities within the first incremental step. Failure to follow these mitigation measures may result in take that counts against the take levels authorized for a particular activity, if take is authorized in an incidental take statement following project-specific consultation on exploration activities. Such instances of take must be reported as indicated in these mitigation measures below.

1. **Established Level A and Level B harassment zones**: Early season field assessments will be undertaken to establish and refine the appropriate Level A and Level B radii for impulsive and continuous noise (Table 9 for example radii to the 160 dB isopleth for impulsive noises and to the 120 dB isopleth for continuous noises). NMFS currently lacks the information to determine the size of Level A zones for the equipment that may be used during Phase 1 of this action (e.g., source level, firing rate of airguns, and duration of firing). Mitigation measures in this section are designed to avoid and minimize take of marine mammals by harassment due to seismic exploration activities (avoid exposure of marine mammals to impulsive sounds in excess of 160 dB). The zone within which impulsive sound exceeds 160 dB, and within which continuous sound exceeds 120 dB, is referred to as the disturbance zone.
2. **Ramp-up and Power-up:** Ramp-ups may only occur when the entire 160 dB disturbance zone is visible and is effectively monitored by one or more PSOs. Note that this may not be feasible from PSOs aboard a single vessel and may require additional monitoring vessels or aerial reconnaissance. A ramp-up of an airgun array provides a gradual

increase in sound levels, and involves a step-wise increase in the number of guns firing and the resulting acoustic output, until the desired operating level of the array is attained.

Power-up procedures cover circumstances in which at least one airgun has been firing[8], and acoustic output is to be increased to desired operational levels. It avoids the requirement for the 30 minute monitoring period prior to the firing of any airguns, although this requirement still applies during a ramp-up procedure.

a. Ramp-up procedures include the following steps: PSOs must monitor the entire 160 dB disturbance zone of the full airgun array for 30 minutes immediately prior to airgun use during a time when the entire zone is visible and effectively monitored; assurance by the PSO that the zone is free of marine mammals; and the gradual increase of airgun array acoustic output at a rate of no more than a 6 dB per 5 minute period. Ramp up will begin with the smallest available airgun. During ramp up, the entire 160 dB disturbance zone of the full airgun array must be visible and must be effectively and constantly monitored by PSOs dedicated solely to this activity.

b. Power-up procedures include the gradual increase of airgun array acoustic output at a rate of no more than a 6 dB increase per 5 minute period. It does not require the PSO's 30-minute monitoring of the 160 dB disturbance zone of the full airgun array, described in the ramp-up procedures, prior to the gradual increase in acoustic output of the airgun array. For power-up procedures that occur during daylight, the 160 dB disturbance zone of the full airgun array will remain constantly monitored by PSOs dedicated solely to this activity. For power-up procedures that occur during low visibility conditions or night-time operations (when the entire 160 dB disturbance zone is not visible), the 160 dB disturbance zone of the full airgun array will remain constantly monitored by PSOs to the extent practicable. Should marine mammals enter or appear likely to enter the 160 dB disturbance zone of the full airgun array, power-down or shutdown procedures will be implemented.

c. If use of the airgun array has been discontinued for less than 10 minutes, and a mitigation gun has been operating during that gap in airgun array operations, and a PSO has been monitoring the 160 dB disturbance zone during that gap in airgun array operations, then airgun array use can resume at full power without ramping up or powering up.

d. If use of the airgun array has been discontinued for less than 10 minutes, and a mitigation gun has not been operating during that gap in airgun array operations, and a PSO has been monitoring the 160 dB disturbance zone during that gap in airgun array operations, then a power-up is required.

[8] often a mitigation gun, but also including airgun arrays operating at less than full power for a particular application or location.

e. If use of the airgun array has been discontinued for less than 10 minutes, and a PSO has not been monitoring the 160 dB disturbance zone during that gap in airgun array operations, then a ramp-up is required regardless of whether or not a mitigation gun was in use.

f. If use of the airgun array has been discontinued for 10-30 minutes, and a mitigation gun has been operating during that gap in airgun array operations, and a PSO has been monitoring the 160 dB disturbance zone during that gap in airgun array operations, then a power-up is required.

g. If use of the airgun array has been discontinued for 10-30 minutes, and a mitigation gun has been operating during that gap in airgun array operations, and a PSO has not been monitoring the 160 dB disturbance zone during that gap in airgun array operations, then a ramp-up is required.

h. If use of the airgun array has been discontinued for 10-30 minutes, and a mitigation gun has not been operating during that gap in airgun array operations, then a ramp-up is required regardless of whether or not a PSO has been monitoring the 160 dB disturbance zone during that gap in airgun array operations.

i. If use of the airgun array has been discontinued for greater than 30 minutes but less than 3 hours a ramp-up is required regardless of whether or not a mitigation gun has been in use and regardless of whether or not a PSO has been monitoring the 160 dB disturbance zone during that gap in airgun array operations. Note, however, that if a PSO has been monitoring the 160 dB disturbance zone during that gap in airgun array operations, the PSO's requirement to monitor the 160 dB disturbance zone of the full airgun array for 30 minutes prior to use of the airgun array will have already been met.

j. Mitigation guns will not be used for over three hours at a time. After three hours of mitigation gun use, a shut-down will occur.

For ease in interpretation, Figure 4 shows a flow diagram indicating some seismic exploration mitigation measures under various scenarios described in mitigation measures 2c-2j.

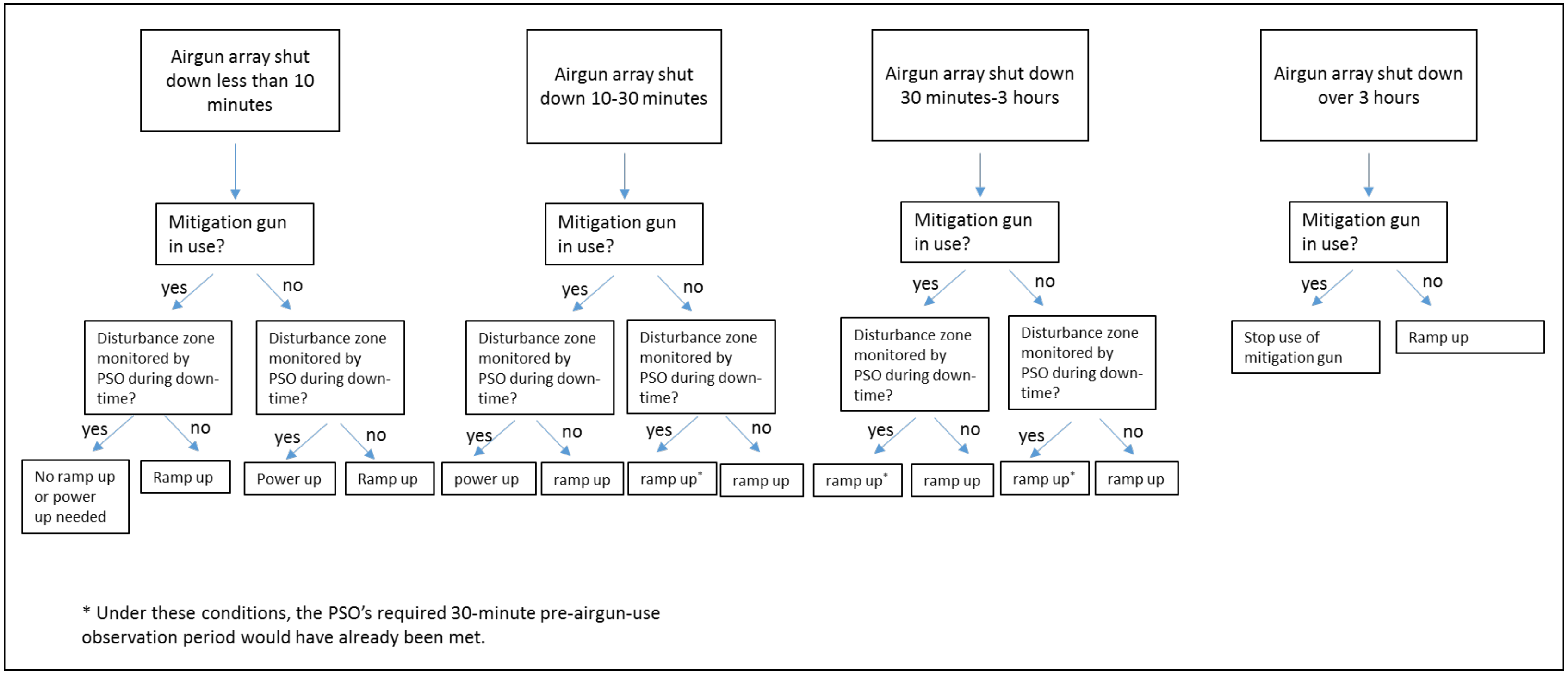

Figure 4. Flow diagram indicating under what conditions ramp-ups, power-ups, or cessation of mitigation gun use are most appropriate, as per the mitigation measures associated with this action.

3. **Power-downs and Shutdowns:** A power-down is the reduction in the number of operating energy sources such that acoustic output is reduced, and the zone within which marine mammal harm or harassment may occur is reduced in size. A shutdown is the immediate discontinuation of all airguns, including the mitigation gun. The airgun arrays will be immediately powered down whenever a marine mammal is observed within the 160 dB disturbance zone of the full airgun array, or is considered by the PSO to be likely to enter that zone. Reduction of acoustic output through power-downs will continue in a way that results in marine mammals remaining exposed to impulsive sounds less than 160 dB. If a marine mammal is observed within the 160 dB disturbance zone of an energy source that cannot be further reduced in acoustic output, that energy source must be shut down.

4. **Following a power-down or shutdown**, operation of acoustic sources will not resume until all marine mammals have cleared the applicable disturbance zone (within which received sound levels exceed 160 dB). If a marine mammal(s) is observed within this zone during ramp-up or power-up, ramp-up/power-up will be delayed until all marine mammals are observed outside of the 160 dB disturbance zone of the full airgun array or until they have not been observed within this zone for at least 15 minutes (for pinnipeds) or 30 minutes (for cetaceans). Following a shut-down during daylight hours (between sunrise and sunset), seismic activity will not commence until the entire 160 dB disturbance zone of the full airgun array is visible. At that time, a ramp-up procedure must be used.

5. **Mitigation Gun:** During periods of transit between survey transects and turns, at least one airgun (a mitigation gun) will remain operational. Ramp-up or power-up procedures may be followed when increasing airgun acoustic output to operational levels provided less than three hours have elapsed since the previous period of operational seismic exploration (see Figure 4 for when ramp-up or power-up procedures should be used). Mitigation guns may not be used for more than three hours, after which a shut-down must occur.

6. **Transiting between transects or survey areas:** If the transit between survey areas is expected to last longer than 30 minutes, the airgun array will be shut down and the mitigation gun will be used, with a ramp-up required before resuming airgun use. If the transit is expected to last for more than three hours, all airgun activity will discontinue, and ramp-up protocols will be followed before continuation of seismic exploration surveys.

7. **Speed and course alterations:** If a marine mammal is detected outside the 160 dB disturbance zone and the PSO determines that the animal is likely to enter that disturbance zone, in lieu of initiating power-down or shut-down procedures, the vessel's speed and/or direction may be altered to reduce the likelihood the marine mammal will enter the disturbance zone. Marine mammal activities and movements relative to the source vessel will be monitored and recorded by the PSO to ensure that marine mammals do not occur within the 160 dB disturbance zone of the full airgun array. If after the

initial change in speed and/or direction the marine mammal still appears likely to enter this zone, further mitigation actions will be taken (e.g., further alterations of vessel direction/speed, or power-down or shutdown of the airgun arrays).

8. **In the event that an injured or dead marine mammal is observed** within 20 nautical miles (roughly 2x the diameter of the largest 160 dB disturbance zone) of the area that underwent seismic exploration during the previous 24 hours, the airguns must be shut down immediately upon observation of the animal by the PSO or non-project-related parties. Photographs of the dead or injured marine mammal will be taken when possible, and both NMFS and the Marine Mammal Stranding Hotline will be immediately notified of the observation (see contact information below). If an assessment, certified by the lead PSO, indicates the marine mammal death was clearly caused by a source not associated with the action (e.g. the carcass shows obvious signs of predation, disease, entanglement, or advanced decomposition), operations may continue with the initiation of power-up or ramp-up procedures as appropriate. If no obvious sign of death is evident, the operator must wait for NMFS authorization to continue survey operations. NMFS authorization can be pursued by calling the numbers listed below:
   NMFS Stranding Hotline (24/7 coverage): 877-925-7773
   NMFS Anchorage Main Office: 907-271-5006
   NMFS Stranding Coordinator: 907-271-1332 or 907-250-8810
   NMFS Protected Resources Supervisor: 907-271-3023 or 907-306-1895

9. **Protected Species Observers (PSO)** will be used to monitor for, and take steps to minimize occurrence of, marine mammals within Level A harm and Level B harassment zones for all operations. Monitoring can be conducted from on-board project vessels, from a support vessel, from land, and/or from aircraft. Monitoring and reporting protocols are important to ensure mitigation measures are implemented appropriately to protect ESA-listed species. These protocols will be developed by NMFS during the course of subsequent section 7 consultations.

Table 9. Example Level B harassment zones associated with oil and gas related activity (Jacobs Engineering 2017, NMFS 2016, NMFS 2017).

Activity	Level B harassment zone radius (disturbance zone)	Basis for disturbance zone radius
Pinger	25 m	NMFS 2016 Apache biological opinion
10 in^3 airgun[1]	280 m	Austin and Warner (2012) (from NMFS (2016)
440 in^3 array	2,500 m	Austin and Warner (2012) (from NMFS (2016)

2,400 in^3 array	9,500 m	Austin and Warner (2011) and (Warner et al. 2011) (from NMFS (2016)
Jack-up rig transport by three tugs	2,154 m, rounded to 2,200 m	170 dB SPL (with practical spreading loss)[1]
Tugs not under load	100 m	150 dB SPL
Pile driving Delmag D-62	5,500 m	190 @ 55m dB (Illingworth and Rodkin 2014, but with practical spreading loss applied)
Pile driving S-90 w/o cushion	550 m	201 dB re 1 µPa @ 1m
Drilling and pumping	330 m	158 dB SPL
Well completion or well plugging and abandonment	330 m	Conservative estimate based on comparison with drilling and pumping, where this activity produces less noise than drilling and pumping.[2]
OSV deliveries/support vessels	100 m	150 dB SPL
Aircraft	230 m or 13° each side of aircraft	230 m = 2x13° m cone radius at water surface for aircraft at 1000 ft.

[1] Based upon SSV of Lauren Foss, a tug that is nearly twice as powerful as the other tugs expected to be used, while on tow.

[2] Pers. Comm. Andrew Lentz, Jacobs Engineering, May 5, 2017

Acoustic Sound Source Verification Measurements

The operator or leaseholder is will conduct acoustic measurements of their equipment (including source arrays) in the field where operations are to take place. These underwater sound source verifications (SSVs) will be used to help determine Level A harm and Level B harassment radii for the equipment to be used. A report on the preliminary results of the SSV, including: 1) the source level of mitigation guns, airgun arrays, and configurations of airguns expected to be used during power down operations, and 2) the 160-dB re 1 µPa $_{RMS}$ Level B take radii of the airgun sources, will be submitted within 5 days after collection and analysis of those measurements. This report will specify the radius of the disturbance zones that were adopted for the survey. Noting that Level A take radii are dependent upon acoustic output, firing rate, and duration of firing, the Level A take radii will require those additional operational inputs, some of which may not be available at the time the SSV is conducted. The measurements will be made at the start of the field season so that the measured radii can be used for the remainder of the survey period.

Protected Species Monitoring

Monitoring for protected species during seismic surveys will be conducted throughout the period of survey operations by PSOs. The observers are stationed aboard the survey source vessel and additional platforms that facilitate effective monitoring of the entire 160 dB disturbance zone. PSO duties include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the survey operations; initiating mitigation measures; and reporting the results. PSOs will have the authority to order power-downs and shutdowns to avoid take of marine mammals.

The observers must be on watch during all daylight periods when the sound sources are in operation. To avoid fatigue, PSO's duty shifts will not exceed four consecutive hours, with one hour minimum breaks between shifts to minimize observer fatigue. PSOs will not work more than three shifts in a 24-hour period (i.e., 12-hour total per day maximum duty time). Observers will be biologists/local experts, who have previous marine mammal observation experience. BOEM and BSEE must require that their lessees, permittees, and agents of their lessees and permittees utilize qualified marine mammal observers. Qualified observers should have documented previous experience as a marine observer or be otherwise able to demonstrate appropriate training or experience.

Monitoring Methods:

The following are the standard monitoring methods used to ensure that appropriate mitigation measures are initiated at the appropriate times.

1. Vantage Point: The observer(s) will watch for marine mammals from the best available vantage point on the operating source vessel, which is usually the bridge or flying bridge. Personnel on the bridge will assist the PSOs in watching for marine mammals.
2. Observer Equipment: Observers will be provided with equipment that enables species ID beyond the largest disturbance zone to be monitored.
3. Marine Mammal Observations: Marine mammal observation data must include the following data for each listed marine mammal observation (or "sighting event" if repeated sightings are made of the same animal or animals):
   3.1. Unique identifier for the PSO reporting the sighting;
   3.2. Species, date and time of each sighting event;
   3.3. Number of animals per sighting event and number of adults/juveniles/calves per sighting event;
   3.4. Primary, and, if observed, secondary behaviors of the marine mammals in each sighting event;
   3.5. Geographic coordinates of both the observed animals and the most proximal actively operating seismic vessel, with the position recorded using the most precise coordinates practicable (coordinates must be recorded in decimal degrees or similar defined and widely-used geographic coordinate system);

3.6. Time of most recent seismic shot (of the most proximal actively operating seismic vessel) prior to marine mammal observation;

3.7. Determination of the number of instances of Level A and Level B take, and project-caused marine mammal mortality that occurred, and a description of the circumstances surrounding each take and mortality.

4. Additional Observations to be Recorded: The ship's position, heading, and speed; the operational state (e.g., number and size of operating energy sources); water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 minutes during a watch, and whenever there is a substantial change in one or more of those variables.

PSO Field Data Recording and Reporting

The following procedures for data recording and verification allow initial summaries of data to be prepared during, and shortly after, the field season, and will facilitate transfer of the data to statistical, graphical, or other programs for further processing. Quality control of the data will be facilitated by the start-of-season training session, subsequent supervision by the lead PSO, and ongoing data checks during the field season.

Recording: The observers will record their observations onto datasheets or directly into an electronic database or spreadsheet.

Verification: The completeness and accuracy of data entry will be verified in the field daily by the lead PSO.

Reporting

1. When marine mammal are injured (e.g. exposed to sounds that cause Level A take, struck by project vessel, exposed to contaminants) or killed, a report must be filed with NMFS within 24 hours.

2. When marine mammals are exposed to sounds or activities capable of causing Level B harassment, reports of such takings will be submitted to NMFS on a weekly basis, with a description of the circumstances surrounding each take.

3. Monthly monitoring reports will be submitted to NMFS by the 15^{th} day of the subsequent month. These reports will include the information described in the Monitoring Methods section above.

4. A seasonal "90-day" report that includes the information in items 4(a) through 4(l) (below) will be submitted no later than 90 days after completion of each field season. Each 90-day report will include:

    a. Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through study period by operational state, sea state, and other factors affecting visibility and detectability of marine mammals).

    b. A table showing the size of each zone for each activity type.

c. Summaries of the occurrence of power-downs, shutdowns, ramp-ups, power-ups, and marine-mammal-caused delays of ramp-ups and power-ups.

d. Analyses of the effects of factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare).

e. Observed marine mammal species, numbers, and distribution, including date, water depth, age/size/gender categories (if determinable), group sizes, and ice cover.

f. Sighting rates of marine mammals by operational state (and other variables that could affect detectability).

g. Initial marine mammal observation distances by operational state of seismic exploration vessel.

h. Closest point of approach of marine mammal, and concurrent operational state of seismic exploration vessel.

i. Observed behaviors and types of movements by operational state.

j. Numbers of sightings/individuals seen during each operational state.

k. Distribution around the acoustic source vessel by operational state.

l. Total known instances of Level A and Level B takes by species.

Exploration and Delineation Drilling

The only impulsive sound associated with drilling is the installation of the conductor pipe, which is completed using a hammer. Otherwise drilling activities generate continuous non-impulsive sounds that are generally stationary in nature (with the exception of tugs moving rigs, and movement of support vessels and aircraft). These stationary and continuous sounds may increase the period of prolonged exposure to harassing levels of sound if the source happens to be at a location that is normally frequented by marine mammals, such as near seasonal concentrations of prey. As described previously for seismic surveys, operators also may be required to delineate and monitor marine mammal Level A harm and Level B harassment zones around drilling rigs if the underwater sound pressure exceeds 120 dB re 1μPa $_{RMS}$. Operators may also be subject to vessel and aircraft mitigation, such as that described in the sections that follow. Furthermore, the Proposed Action prohibits exploration drilling in beluga whale critical habitat between November 1 and April 1 when beluga whales are most likely to be present. These restrictions serve to further minimize impacts to both beluga whales and their critical habitat.

Vessel Operations

There are a wide variety of vessels of different types and sizes that operate in support of exploration activities. These vessels typically conform to the following operational procedures with respect to whales, as stipulated in MMPA incidental harassment authorizations (IHAs) or letters of authorization (LOAs):

Minimum distance: Consistent with NMFS marine mammal viewing guidelines, operators of vessels should, at all times, avoid approaching within 100 yards (91 m) of marine mammals.

Changes in direction: Vessel operators should avoid multiple changes in direction when within 300 yards (274 m) of marine mammals; however, those vessels capable of steering around such groups should do so in a way that avoids the marine mammals and does not cut them off (e.g., maneuver away from the marine mammals' direction of travel).

Changes in speed: Vessels should avoid multiple speed changes; however, vessels should slow down when within 300 yards (274 m) of marine mammals, especially during poor visibility, to reduce the potential for collisions.

Groups of marine mammals: Vessels may not be operated in such a way as to separate members of a group of marine mammals.

Aircraft Operations

Aircraft are typically required to operate within specific height and distance parameters with respect to marine mammals and birds. These include the following:

All aircraft: Aircraft are typically required to operate at least 1,500 ft (457 m) above sea level when within 500 lateral yards (457 m) of marine mammals, except during an emergency or to maintain safety.

Helicopters: Helicopters may not hover or circle above marine mammals.

Inclement weather: When weather conditions do not allow a 1,500 ft (457 m) flying altitude, such as during storms or when cloud cover is low, aircraft may be operated below 1,500 ft (457 m), but the operator should avoid known marine mammal concentration areas and take precautions to avoid flying directly over or within 500 yards (457 m) of marine mammals.

Support aircraft: Support aircraft must avoid extended flights over the coastline to minimize effects on marine mammals and birds in nearshore waters or along the coast.

NMFS Contact Information

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Barbara Mahoney

Marine Mammal Biologist
Barbara.Mahoney@noaa.gov
907-271-3448 (w)
907-331-8528 (c)

NMFS Stranding Hotline (manned 24/7)
877-925-7773

2.5.5 Onshore Operations

First Incremental Step
Onshore activities during the first incremental step are limited to support operations, which are assumed to use existing facilities at Homer or Nikiski. All onshore activities during the first incremental step would be subject to permits, authorizations, stipulations, required operating procedures (ROPs), and best management practices (BMPs) as recommended or required by the appropriate land-based resource and management agencies.

Future Incremental Steps
Future incremental steps are expected to include two pipeline landfalls (one oil and one gas), probably on the southern Kenai Peninsula near Homer or Nikiski. It is assumed there will be onshore oil and gas pipelines 80 km (50 mi) long. Locations of pipeline routes and landfalls will depend on where a commercial discovery is made, but are expected to be within the Action Area.

All onshore activities during Future incremental steps would be subject to permits, authorizations, stipulations, ROPs, and BMPs as recommended or required by the appropriate land-based resource and management agencies.

2.5.6 Opportunities for Intervention and Spill Response

In the event of an oil spill, response operations could occur that may cause small amounts of acoustic harassment, but which will seek to reduce the volume of spilled material and spatial extent of the spill, thereby potentially decreasing the environmental effects of the spill. Oil spill response methods and activities are not mutually exclusive, and several techniques may be employed contemporaneously. The availability and effectiveness of each technique may vary with environmental conditions and oil characteristics. For example, offshore intervention activities may be hampered during winter months by low temperatures, the presence of ice, unfavorable seas and weather, darkness, and other factors.

- **Mechanical Recovery**: Physical removal of oil from the sea surface, typically accomplished using containment booms and skimmers. Boom would be deployed on the sea surface and positioned within or around an oil slick to contain and concentrate the oil into a pool thick enough to permit collection by a skimmer. The recovered oil would be transferred to a storage vessel (e.g., barge or tanker) and subsequently transferred to shore for appropriate recycling or disposal.
- **Dispersants**: Chemical dispersants are a combination of solvents and surfactants that are applied to oil to promote the dispersion process and form smaller droplets. Smaller droplets may then remain submerged rather than rising to the sea surface, spreading, and potentially contacting land. Dispersion into smaller droplets results in greater surface areas available

for microbial degradation, and eventual dissolution. Dispersant use is generally limited to waters > 10 m in depth. To receive authorization to use dispersants, a Dispersant Use Request must be submitted by the Responsible Party to the Federal On-Scene Coordinator (FOSC), as described in the Alaska Unified Plan. The FOSC, in consultation with representatives from the Department of Commerce (DOC), Department of Interior (DOI), and EPA's Alaska Regional Response Team (ARRT), and the State On-Scene Coordinator, will review the Dispersant Use Request and grant authorization, if warranted. Dispersants may be aerially applied using low-flying aircraft (i.e., aircraft flying < 46 m [150 ft] above the sea surface), or from offshore vessels. Dispersants also may be applied directly at the subsea source of the release using a remotely operated vehicle. The use of dispersants in the presence of cold water and ice is discussed in the Final Second Supplemental EIS for Lease Sale 193, Section 4.4.2.2.8 (BOEM 2015b).

- **In Situ Burning**: Intentional ignition of floating oil at the sea surface is conducted to enhance volatilization of the lighter compounds in oil. Burning causes temperatures to increase at the sea surface, and temporary air quality issues, and generates residues that may float or sink.

2.5.7 Statewide Marine Mammal Spill Preparedness and Response Standards

The Oil Pollution Act of 1990 (OPA-90) expanded the Federal government's ability to prevent and respond to oil spills. OPA-90 established new requirements for contingency planning by government and industry by expanding the National Contingency Plan to a three-tiered system: 1) the Federal government, through the National and Regional Response Team(s) were empowered to direct all public and private response efforts for certain types of spill events through their corresponding Response Plans; 2) Area Committees (composed of Federal, state, and local government officials) were required to develop detailed, location-specific Area Contingency Plans; and 3) owners or operators of vessels and certain facilities that pose a serious threat to the environment must prepare their own Facility Response Plans.

In an effort to assist with emergency response preparedness for marine mammals under NMFS jurisdiction in Alaska, the NMFS Alaska Region Protected Resources Division (AKR PRD) has developed the following general guidelines and standards for response capacity by responsible parties.

- **Preparedness and Response Standards and Thresholds (Initial Immediate Response)**
    - Samples: Prepare to sample 50 live or dead pinnipeds (i.e., bearded seal, harbor seal, ribbon seal, ringed seal, spotted seal, northern fur seal, and/or Steller sea lion) the first week. Prepare to sample 5 live or dead cetaceans (i.e., whales and porpoise) the first week. After the first week, the Responsible Party (RP) has the responsibility to fund the storage of carcasses, fund transport to approved facilities for analysis, and fund additional sampling or any live or dead pinnipeds or cetaceans. Sampling shall be performed by an individual or entity approved under NMFS Marine Mammal Health and Stranding Permit #18786.
    - Necropsy: Prepare to necropsy 50 dead pinnipeds and/or cetaceans. Necropsies shall be performed and samples stored by an individual or entity approved under NMFS Marine Mammal Health and Stranding Permit #18786. If mortalities exceed 50 animals, the RP has the responsibility to fund the storage of carcasses and fund transport to approved facilities for analysis.

  - Sample storage: Maintain level of readiness to store 1,000 marine mammal samples, which likely includes multiple samples from individual animals, and therefore, does not represent 1,000 animals. Samples shall be stored by an individual or entity approved under NMFS Marine Mammal Health and Stranding Permit #18786.
  - Cleaning/rehabilitation threshold: The following thresholds apply for live moribund animals whose condition can withstand transport.
    - *Pinnipeds:* The RP should maintain a level of readiness for 25 live pinnipeds to be cleaned and rehabilitated.
    - This applies to bearded, ringed, ribbon, spotted, harbor, and northern fur seals and Steller sea lions. However, capturing and cleaning oiled adult Steller sea lions is generally not feasible given their size and the difficulties in their collection and transport, as well as danger to response personnel.
    - It may not be feasible to capture oiled northern fur seals. Human safety must be a primary consideration as it may be dangerous to response personnel to capture oiled fur seal pups because of territorial bulls, and oiled adult fur seals would be extremely dangerous to handle, even if partially debilitated. Also, separating a pup from its mother temporarily may lead to abandonment.
    - Approved cleaning protocols and practices by species can be found in the Wildlife Protection Guidelines in the Alaska Unified Response Plan and NMFS National Marine Mammal Oil Spill Guidelines.
    - All cleaned pinnipeds must be tagged prior to release to monitor survivorship. Per a request from the Ice Seal Committee, we recommend that ice seals (bearded, ringed, ribbon, and spotted seals) that are transported outside their region of capture not be released back to the wild after rehabilitation. This request does not apply to ice seals captured and cleaned on-site.

    - *Cetaceans:* The RP should maintain a level of readiness for two live small cetaceans (e.g., young beluga whale, young killer whale, or porpoise) to be cleaned and rehabilitated.
- **Readiness Time Horizon**
  - Maintain readiness for additional sampling, necropsies, sample storage, and cleaning/rehabilitation for up to one year post-spill.
  - After the official closure of a spill response, RPs should remain prepared to support NMFS and wildlife response organizations to respond to oil-affected marine mammals under NMFS jurisdiction.
- **Authority**
  - Response authority for oiled marine mammals under NMFS jurisdiction is always retained by NMFS, and interventions can be authorized only by NMFS on a case by case basis. During a spill, authority to respond to oiled marine mammals may be granted under the NMFS Marine Mammal Health and Stranding Response Permit #18786 issued to Dr. Teri Rowles and her authorized NMFS Co-Investigators. Pre-authorization is not a component of this response structure.

- In the future, NMFS plans to add a spill response component to language in Regional Stranding Agreements, which would allow agreement holders to respond to non-ESA listed MMPA species in the event of an oil spill. Response to ESA-listed marine mammals would still require authorization under NMFS permit #18786 as specified above.

- **Spill Response Network Model**
    - Preparedness and response shall be led through a NMFS approved contractor (e.g., Alaska SeaLife Center [ASLC]) under U.S. Coast Guard's Oil Spill Removal Organization (OSRO) program, after obtaining authorization through NMFS permit #18786. NMFS will provide guidance regarding: 1) marine mammal response standards, 2) training requirements, and 3) regulatory pathways for response authorizations (e.g., authorizing marine mammal responses pursuant to NMFS permit #18786). NMFS will maintain contact information on trained stranding network members and Incident Command System staff. NMFS-approved wildlife responders will facilitate preparedness for the stranding network as a primary field response participant, along with trained stranding network members. OSROs will need to work with NMFS-approved wildlife response organizations to ensure preparedness levels are sufficient for a rapid response to oiled marine mammal under NMFS jurisdiction. Currently, NMFS does not have the in-house capacity to lead field efforts, so will act in a guidance and oversight capacity through the Incident Command System's Wildlife Branch.

- **Adding Stranding Agreement Holders**
    - NMFS will continue to approach qualified entities and individuals throughout Alaska to encourage participation and engagement in the Alaska Marine Mammal Stranding Network. A focused effort is underway to further develop response capacity in the Kodiak and Cook Inlet regions. Training will need to be provided to new stranding network members at annual stranding network meetings or by other mechanisms.

2.5.8 Additional Mitigation Measures

Additional mitigation measures related to exploration, development, production, and de-commissioning may be required by NMFS for site-specific activities as specified in an Incidental Take Statement or by BOEM in a specific exploration plan or development and production plan or by BSEE in a drilling permit. However, since those measures would be addressed in future ESA section 7 consultations and may, or may not, be incorporated in future permits and authorizations, they are not considered as part of this proposed action.

2.6 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). For this reason, the action area is typically larger than the project area and extends out to a point where no measurable effects from the proposed action occur.

The action area for this biological opinion will include: (1) 224 lease blocks contained within LS 244 in Cook Inlet which includes seismic, geohazard, and drilling sites; (2) a sound propagation buffer area surrounding the LS 244 area; (3) waters and shorelines of Cook Inlet and the Shelikof Strait based on the Oil-Spill Risk Analysis (OSRA); and (4) vessel and aircraft transit areas from Kenai/Nikiski or Homer to the lease area. The action area encompasses approximately 27,530 square kilometers (Figure 5). In total, LS 244 covers 4,404 square kilometers of water in depths ranging from 0.3 m (1 ft) over a shoal in the northern section of the proposed lease area to 95 m (311 ft) in a trough that runs down the center of Cook Inlet.

BOEM is proposing to authorize oil and gas exploration activities within the 224 lease blocks on LS 244. Within this area, the loudest sound source with the greatest propagation distance is anticipated to be the 2,400 in^3 airgun array based on previous oil and gas operations in Cook Inlet. Received levels from this marine seismic survey with a source level of 238 dB (Austin and Warner 2012), may be expected on average to decline to 160 dB re 1 μPa (rms) within 9.5 km of the lease area assuming practical spreading loss (15 Log R). While project noise may propagate beyond the 160 dB isopleth, we do not anticipate that marine mammals would respond in a biologically significant manner at these low levels to an impulsive sound source and at a great distance from the source. The ~10 km sound propagation buffer around the LS 244 lease area boundary assumes that a source vessel engaged in transmitting seismic impulses occurred on the outer boundary of the lease blocks using an array of about 2,400 in^3 displacement, which is a typical maximum array size for recent seismic surveys in Cook Inlet.

The OSRA looked at probabilities of various sized spills contacting waters and shorelines of Cook Inlet and Shelikof Strait. Based on these possible spills, the boundary of the action area extends from the LS 244 area southeast to the Kennedy Entrance of Cook Inlet and south into Shelikof Strait past Karluk, Alaska. Additional information on hypothetical oil spill trajectories can be found in Appendix A of the FEIS (BOEM 2016 b), and below in Sections 6.1.3.8 and 6.2.6.

Mobilization, demobilization, and resupply vessels are anticipated to traverse from Kenai / Nikiski or Homer to well locations or seismic vessel locations (BOEM 2017b). These transit routes will also have a sound propagation buffer associated with vessel noise that may range from 100 m to 2.2 km depending on the vessel type whereby typical supply vessels will likely have a disturbance zone of about 100 m in radius, while tugs engaged in towing may have much larger disturbance zones (Jacobs Engineering 2017). Based on these transit routes, the boundary of the action area extends from the LS 244 area north in Cook Inlet to above Kenai and Nikiski, Alaska.

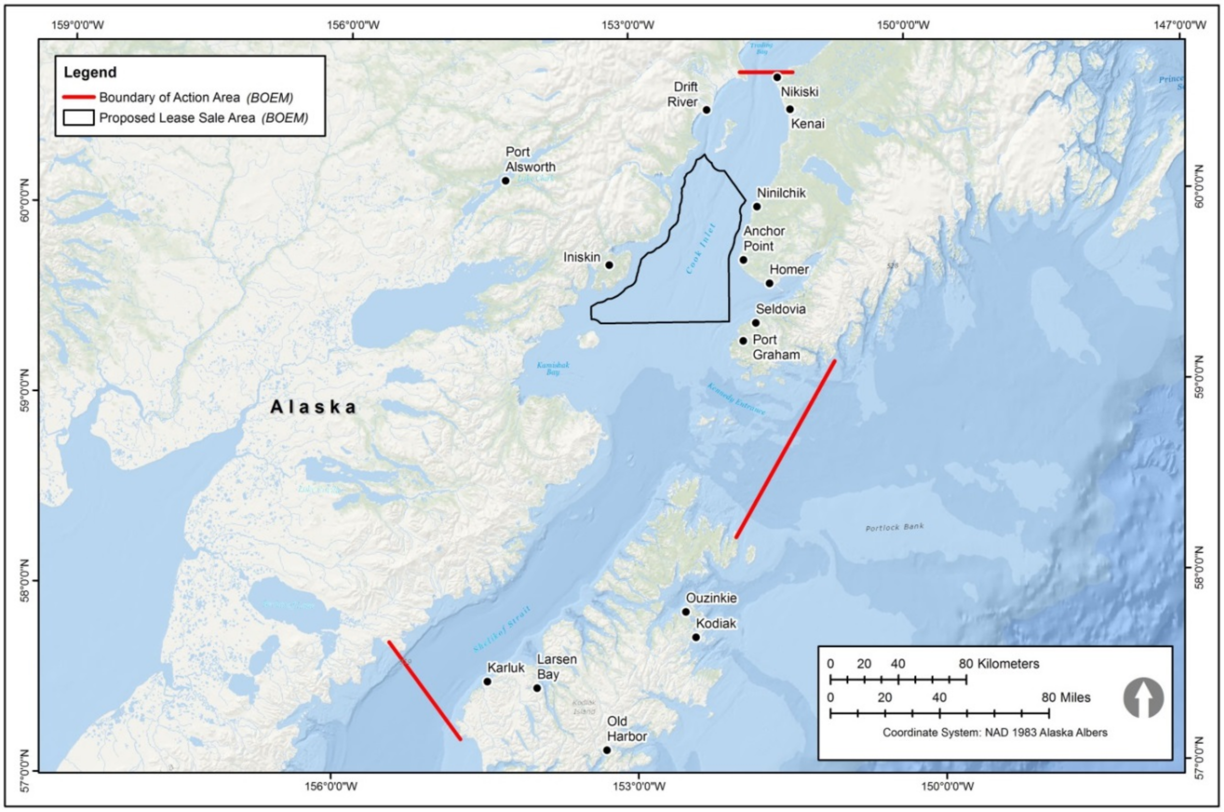


Figure 5. Action Area Map for Lease Sale 244 (BOEM 2017b).

3 APPROACH TO THE ASSESSMENT

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts to the conservation value of the designated critical habitat.

To "jeopardize the continued existence" of a listed species means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). As NMFS explained when it promulgated this definition, NMFS considers the likely impacts to a species' survival as well as likely impacts to its recovery. Further, it is possible that in certain, exceptional circumstances, injury to recovery alone may result in a jeopardy biological opinion (51 FR 19926, 19934; June 3, 1986).

Under NMFS's regulations, the destruction or adverse modification of critical habitat "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (50 CFR §402.02).

Historically, the designation of critical habitat for Cook Inlet beluga whales and Steller sea lions used the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414; February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCEs or essential features, as appropriate for the specific critical habitat.

We use the following approach to determine whether the proposed action described in Section 2.0 is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on listed species or critical habitat. As part of this step, we identify the action area – the spatial and temporal extent of these direct and indirect effects.
- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action. This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. We determine the rangewide status of critical habitat by examining the condition of its PBFs - which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 4 of this opinion.

- Describe the environmental baseline including: past and present impacts of Federal, state, or private actions and other human activities *in the action area*; anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation; and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 5 of this opinion.
- Analyze the effects of the proposed actions. Identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). NMFS also evaluates the proposed action's effects on critical habitat features. The effects of the action are described in Section 6 of this opinion.
- Once we identify which listed species are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed species are likely to respond given their exposure (these represent our *response analyses*). Response analysis is considered in Section 6.2 of this opinion.
- Describe any cumulative effects. Cumulative effects, as defined in NMFS's implementing regulations (50 CFR §402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 7 of this opinion.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat. In this step, NMFS adds the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to assess whether the action could reasonably be expected to:
(1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 4). Integration and synthesis with risk analyses occurs in Section 8 of this opinion.
- Reach jeopardy and destruction or adverse modification conclusions. Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 9. These conclusions flow from the logic and rationale presented in the Integration and Synthesis Section 8.
- If necessary, define a reasonable and prudent alternative to the proposed action. If, in completing the last step in the analysis, NMFS determines that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, NMFS must identify a reasonable and prudent alternative (RPA) to the action.

3.1 Exposure Analyses

As we previously mentioned in this opinion, when conducting an incremental step consultation, often times information on the specific number, location, timing, frequency, and intensity of actions is unknown; and any incidental take resulting from the proposed action will be better addressed in subsequent section 7 consultation when that specific information is available. For these reasons, conducting a quantitative exposure analyses where we identify listed resources that are likely to co-occur with effects of a proposed action in space and time and describe the nature of that co-occurrence can be impractical at this earlier step. In these situations, including in this biological opinion, we conduct a qualitative analysis that recognizes that subsequent site specific actions are subject to additional section 7 consultations, and that during those consultations, NMFS, BOEM, and BSEE will address the site specific effects.

3.2 Response Analyses

Once we identify which listed resources are likely to be exposed to stressors associated with the proposed action, and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how (1) endangered or threatened species are likely to respond following exposure and the set of physical, physiological, behavioral, or social responses that are likely and (2) the action is likely to affect the quantity, quality, or availability of one or more of the physical or biological features of critical habitat.

Conceptual Model for Response Analyses

To guide our response analyses, we use a conceptual model of responses to noise (which is the principal stressor included in the proposed action). The model is based on animal behavior and behavioral decision-making (Figure 6), although we recognize the risks presented by physical trauma and noise-induced losses in hearing sensitivity (threshold shift). This model is also based on a conception of "hearing" that includes cognitive processing of auditory cues, rather than focusing solely on the mechanical processes of the ear and auditory nerve. Our model incorporates the primary mechanisms by which behavioral responses affect the longevity and reproductive success of animals: changing an animal's energy budget, changing an animal's time budget (which is related to changes in an animal's energy budget), forcing animals to make life history trade-offs (for example, engaging in evasive behavior such as deep dives that involve short-term risks while promoting long-term survival), or changes in social interactions among groups of animals (for example, interactions between a whale cow and her calf).

This conceptual model begins with the specific acoustic stimuli that we focus on in an assessment (Box 1 in Figure 6). Although we generally considered different acoustic stimuli separately, we considered a single source of multiple acoustic stimuli as a complex "acoustic object" that has several acoustic properties. For example, we treat pulses produced by seismic sound sources and sounds produced by the source vessel as a single "acoustic object" that produced continuous sounds (e.g., engine noise, propeller cavitation, hull displacement, etc.) and periodic impulsive pulses (e.g., seismic airgun array, sub-bottom profiler). Because animals would be exposed to this complex of sounds produced by a single, albeit moving, source over time, we assumed they would generally respond to the acoustic stream associated with this single acoustic object moving through their environment. Multiple ships associated with a particular type of survey, for instance 3D seismic surveys, are expected to also represent a single acoustic object as all vessels are moving in formation at the same speeds while alternating shots. Multiple ships associated with drilling operations, such as support ships that move independently of the survey formation would represent different acoustic objects in the acoustic scene of endangered and threatened marine animals.

Acoustic stimuli can represent two different kinds of stressors: *processive stressors*, which require high-level cognitive processing of sensory information, and *systemic stressors*, which usually elicit direct physical or physiological responses and, therefore, do not require high-level cognitive processing of sensory information (Herman and Cullinan 1997, Anisman and Merali 1999, de Kloet et al. 2005a, de Kloet et al. 2005b, Wright et al. 2007). Disturbance from surface vessels and airguns would be examples of processive stressors while ship strikes would be an example of a systemic stressor. The proposed action may result in two general classes of responses:

1. responses that are influenced by an animal's assessment of whether a potential stressor poses a threat or risk (see Figure 6: Behavioral Response).
2. responses that are not influenced by the animal's assessment of whether a potential stressor poses a threat or risk (see Figure 6: Physical Response).

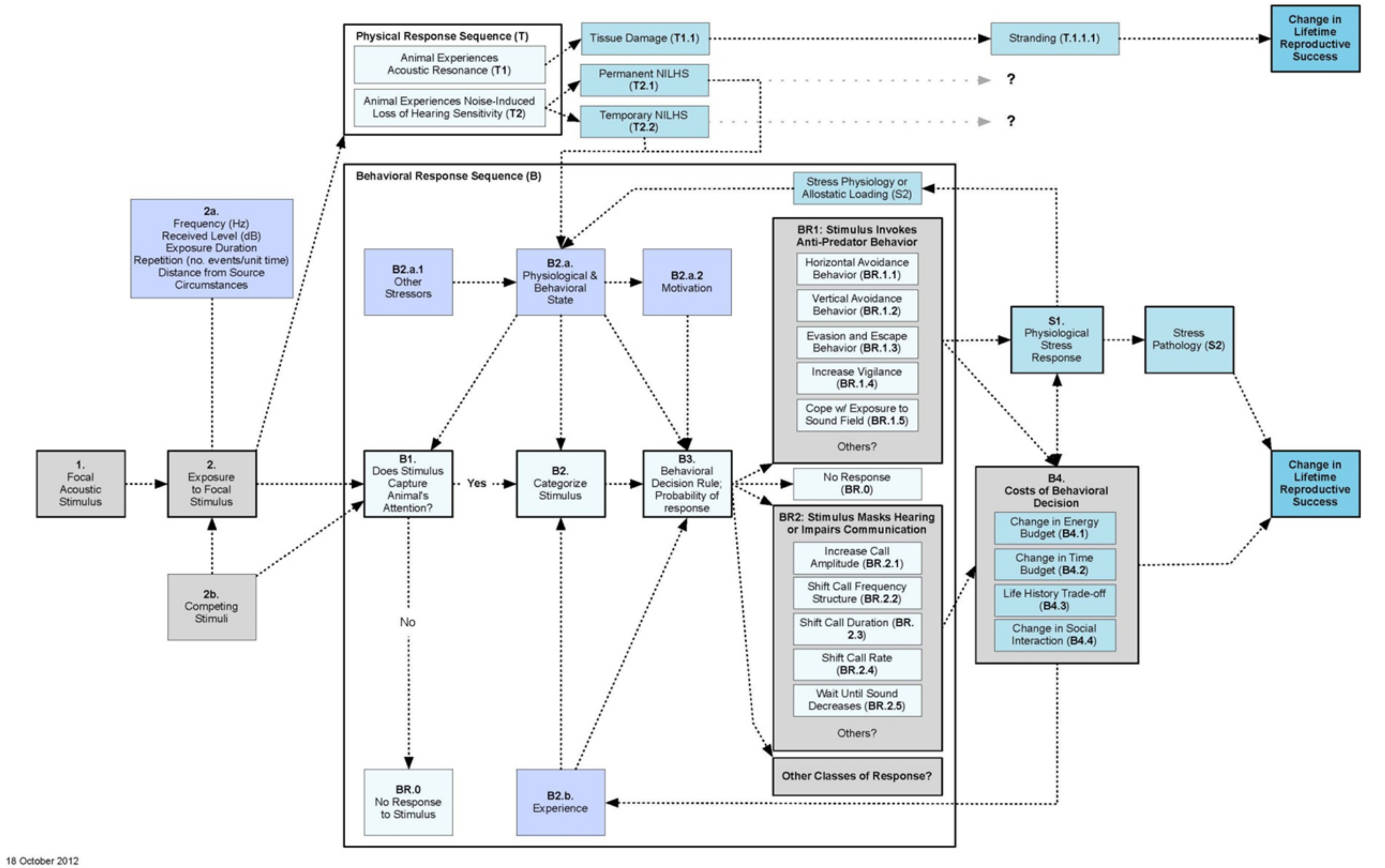


Figure 6. **Conceptual model of the potential responses of listed species upon exposure to an active acoustic sources, and the pathways by which those responses might affect the fitness of individual animals that have been exposed.**

Our conceptual model explicitly recognizes that other acoustic and non-acoustic stimuli (the competing stimuli) that occur in an animal's environment might determine whether a focal stimulus (the stimulus most immediately confronting the animal) is salient to a focal animal (see the line connecting Box 2b to Box 2 in Figure 6). The salience of an acoustic signal will depend, in part, on its signal-to-noise ratio and, given that signal-to-noise ratio, whether an animal will devote attentional resources to the signal or other acoustic stimuli (or ambient sounds) that might compete for the animal's attention (the line connecting Box 2b to Box B1 in Figure 6).[9] That is, an acoustic signal might not be salient (1) because of a signal-to-noise ratio or (2) because an animal does not devote attentional resources to the signal, despite its signal-to-noise ratio. Absent information to the contrary, we generally assume that an acoustic stimulus that is "close" to an animal (within 10 – 15 kilometers) would remain salient regardless of competing stimuli and would compete for an animal's attentional resources. By extension, we also assume that any behavioral change we might observe in an animal would have been caused by a focal stimulus rather than competing stimuli. However, as the distance between the source of a specific acoustic signal and a receiving animal increases, we assume that the receiving animal is less likely to devote attentional resources to the signal.

If we assume that an acoustic stimulus, such as a seismic or drilling source, was salient to an animal or population of animals, we would then ask how an animal might classify the stimulus as a cue about its environment (Box B2 in Figure 6) because an animal's response to a stimulus in its environment depends upon whether and how the animal converts the stimulus into information about its environment (Blumstein and Bouskila 1996, Yost 2007). For example, if an animal classifies a stimulus as a "predatory cue," that classification will invoke a suite of potential physical, physiological, or behavioral responses that are appropriate to being confronted by a predator (this would occur regardless of whether a predator is, in fact, present).

By incorporating a more expansive concept of "hearing," our conceptual model departs from earlier models which have focused on the mechanical processes of "hearing" associated with structures in the ear that transduce sound pressure waves into vibrations and vibrations to electro-chemical impulses. That conception of hearing resulted in assessments that focus almost exclusively on active acoustic sources while discounting other acoustic stimuli associated with activities that marine animals might also perceive as relevant. That earlier conception of hearing also led to an almost singular focus on the intensity of the sound (its received level in decibels) as an assessment metric and noise-induced hearing loss as an assessment endpoint.

Among other considerations, the earlier focus on received level and losses in hearing sensitivity failed to recognize several other variables that affect how animals are likely to respond to acoustic stimuli:

1. "hearing" includes the cognitive processes an animal employs when it analyzes acoustic impulses (see Bregman 1990, Blumstein and Bouskila 1996, Hudspeth 1997, Yost 2007),

[9] See Blumstein and Bouskila (1996) for a review of the literature on how animals process and filter sensory information, which affects the subjective salience of sensory stimuli. See Clark and Dukas (2003), Dukas (2002), and Roitblat (1989) for more extensive reviews of the literature on attentional processes and the consequences of limited attentional resources in animals.

which includes the processes animals employ to integrate and segregate sounds and auditory streams and the circumstances under which they are likely to devote attentional resources to an acoustic stimulus.

2. animals can "decide" which acoustic cues they will focus on and their decision will reflect the salience of a cue, its spectral qualities (sound characteristics), and the animal's physiological and behavioral state when exposed to the cue.

3. animals not only perceive the received level (in dB) of a sound source, but they also perceive their distance from a sound source. Further, animals are more likely to devote attentional resources to sounds that are close than to sounds that are distant.

4. both received levels and the spectral qualities of sounds degrade over distance so the sound perceived by a distant receiver is not the same sound at the source.

As a result of this shift in focus, we have to consider more than the received level of a particular low- or mid-frequency wave form and its effects on the sensitivity of an animal's ear structure. We also have to distinguish between different auditory scenes; for example, animals will distinguish between sounds from a source that is moving away, sounds produced by a source that is approaching them, sounds from multiple sources that are all approaching, sounds from multiple sources that appear to be moving at random, etc.

Animals would then combine their perception of the acoustic stimulus with their assessment of the auditory scene (which include other acoustic stimuli) and their awareness of their behavioral state, physiological state, reproductive condition, and social circumstances to assess whether the acoustic stimulus poses a risk and the degree of risk it might pose, such as whether it is impairing their ability to communicate with conspecifics, whether it is impairing their ability to detect predators or prey, etc. We assume that animals would categorize an acoustic source differently if the source is moving towards its current position (or projected position), moving away from its current position, moving tangential to its current position, if the source is stationary, or if there are multiple acoustic sources it its auditory field.

This process of "categorizing a stimulus" (Box B2 in Figure 6) lends meaning to a stimulus and places the animal in a position to decide whether and how to respond to the stimulus (Blumstein and Bouskila 1996). How an animal categorizes a stimulus will determine the set of candidate responses that are appropriate in the circumstances. That is, we assume that animals that categorize a stimulus as a "predatory cue" would invoke candidate responses that consisted of anti-predator behavior rather than foraging behavior (Blumstein and Bouskila 1996, Bejder et al. 2009).

We then assume that animals apply one or more behavioral decision rules to the set of candidate responses that are appropriate to the acoustic stimulus as it has been classified (Box B3 in Figure 6). Our use of the term "behavioral decision rule" follows Blumstein and Bouskila (1996), and Lima and Dill (1990b), and is synonymous with the term "behavioral policy" of McNamara and Houston (1986b): the process an animal applies to determine which specific behavior it will select from the set of behaviors that are appropriate to the auditory scene, given its physiological and behavioral state when exposed and its experience. Because we would never know the behavioral policy of an individual, free-ranging animal, we treat this policy as a probability distribution function that matches a particular response in the suite of candidate behavioral responses.

Once an animal selects a behavioral response from a set of candidate behaviors, we assume that any change in behavioral state would represent a shift from an optimal behavioral state (or behavioral act) to a sub-optimal behavioral state (or behavioral act) as the animal responds to a stimulus such as acoustic sound sources. That selection of the sub-optimal behavioral state or act could be accompanied by *canonical costs*, which are reductions in the animal's expected future reproductive success that would occur when an animal engages in suboptimal behavioral acts (McNamara and Houston 1986b).

Specifically, canonical costs represent a reduction in current and expected future reproductive success (which integrates survival and longevity with current and future reproductive success) that would occur when an animal engages in a sub-optimal, rather than an optimal, sequence of behavioral acts, given the pre-existing physiological state of the animal in a finite time interval (McFarland and Sibly 1975, McNamara and Houston 1982, McNamara and Houston 1986a, Houston et al. 1993, McNamara 1993, McNamara and Houston 1996, Nonacs 2001, Crone et al. 2013). Canonical costs would generally result from changes in animals' energy budgets (Sapolsky 1997, Moberg 2000, McEwen and Wingfield 2003, Wingfield and Sapolsky 2003, Romero 2004), time budgets (Sutherland 1996, Frid and Dill 2002a), life history trade-offs (Cole 1954, Stearns 1992), changes in social interactions (Sutherland 1996), or combinations of these phenomena (see Box B4 in Figure 6). We assume that an animal would not incur a canonical cost if they adopted an optimal behavioral sequence (see (McNamara and Houston 1986b) for further treatment and discussion).

This conceptual model does not require us to assume that animals exist in pristine environments; in those circumstances in which animals are regularly or chronically confronted with stress regimes that animals would adapt to by engaging in sub-optimal behavior, we assume that a change in behavior that resulted from exposure to a particular stressor or stress regime either would contribute to sub-optimal behavior or would cause animals to engage in behavior that is even further from optimal.

3.3 Risk Analyses

Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been defined by the ESA. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (that is, the probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations is determined by the fate of the individuals that comprise them.

Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

If the quantity, quality, or availability of the physical or biological features of designated critical habitat are altered or reduced, we consider whether those alterations or reductions are likely to be sufficient to diminish the conservation value of the designated critical habitat for listed species in the action area.

If the conservation value of designated critical habitat in the action area is diminished, the final step of our analyses considers whether that diminishment is likely to be sufficient to likewise diminish the conservation value of the entire critical habitat designation.

3.4 Treatment of Cumulative Impact

The effects analyses of biological opinions consider the impacts on listed species and designated critical habitat that result from the incremental impact of an action by identifying natural and anthropogenic stressors that affect endangered and threatened species throughout their range (the *Status of the Species*) and within an action area (the *Environmental Baseline*, which articulates the *impacts* of pre-existing activities that occur in an action area, including the past, contemporaneous, and future *impacts* of those activities). We assess the effects of a proposed action by adding the direct and indirect effects to the *impacts* of the activities we identify in an *Environmental Baseline* (50 CFR §402.02), in light of the impacts of the status of the listed species and designated critical habitat throughout their range.

3.5 Brief Background on Sound

Sound is a wave of pressure variations propagating through a medium (for this consultation, the sounds generated by seismic and electromechanical equipment propagates through marine water as its medium). Pressure variations are created by compressing and relaxing the medium. Sound measurements can be expressed in two forms: *intensity* and *pressure*. Acoustic intensity is the average rate of energy transmitted through a unit area in a specified direction and is expressed in watts per square meter. Acoustic intensity is rarely measured directly, and instead is derived from ratios of *pressures*; the standard reference pressure for underwater sound is 1 µPa; for airborne sound, the standard reference pressure is 20 µPa (Richardson et al. 1995a).

Acousticians have adopted a logarithmic scale for sound intensities, which is denoted in decibels (dB). Decibel measurements represent the ratio between a measured pressure value and a reference pressure value (in this case, for underwater sound, 1 µPa or, for airborne sound, 20 µPa.). The logarithmic nature of the scale means that each 10 dB increase is a ten-fold increase in power (e.g., 20 dB is a 100-fold increase, 30 dB is a 1,000- fold increase). The term “sound pressure level” implies a decibel measure and a reference pressure that is used as the denominator of the ratio. Throughout this opinion, we use 1 µPa as a standard reference pressure, unless noted otherwise.

It is important to note that decibels underwater and decibels in air are not the same and cannot be directly compared. Because of the different densities of air and water and the different decibel standards in water and air, a sound with the same intensity (i.e., power) in air and in water would be approximately 63 dB quieter in air.

Sound frequency is measured in cycles per second, or Hz, and is analogous to musical pitch; high-pitched sounds contain high frequencies and low-pitched sounds contain low frequencies. Natural sounds in the ocean span a huge range of frequencies: from earthquake noise at 5 Hz to harbor porpoise clicks at 150,000 Hz. These sounds are so low or so high in pitch that humans cannot hear them; acousticians call these infrasonic and ultrasonic sounds, respectively. A single sound may be made up of many different frequencies together. Sounds made up of only a small range of frequencies are called “narrowband,” and sounds with a broad range of frequencies are called “broadband”; airguns are an example of a broadband sound source and sonars are an example of a narrowband sound source.

When considering the influence of various kinds of noise on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Most dolphins, for instance, have excellent hearing at very high frequencies between 10,000 and 100,000 Hz. Their sensitivity at lower frequencies below 1000 Hz, however, is quite poor. On the other hand, the hearing sensitivity of most baleen whales appears to be best at frequencies between about between 20 Hz-5 kHz, with maximum sensitivity between 100-500 Hz (Erbe 2002b). As a result, baleen whales might be expected to suffer more harmful effects from low frequency noise than would dolphins.

When sound travels away from its source, its loudness decreases as the distance traveled by the sound increases. Thus, the loudness of a sound at its source is higher than the loudness of that same sound a kilometer distant. Acousticians often refer to the loudness of a sound at its source as the *source level* and the loudness of sound elsewhere as the *received level*. For example, a humpback whale 9 kilometers from an airgun that has a source level of 230 dB may only be exposed to sound that is 160 dB loud. As a result, is important not to confuse source levels and received levels when discussing the loudness of sound in the ocean.

As sound moves away from a source, its propagation in water is influenced by various physical characteristics, including water temperature, depth, salinity, and surface and bottom properties that cause refraction, reflection, absorption, and scattering of sound waves. Oceans are not homogeneous and the contribution of each of these individual factors is extremely complex and interrelated. Sound speed in seawater is generally about 1,500 meters per second (5,000 feet per second) although this speed varies with water density, which is affected by water temperature, salinity (the amount of salt in the water), and depth (pressure). The speed of sound increases as temperature and depth (pressure), and to a lesser extent, salinity, increase. The variation of sound speed with depth of the water is generally presented by a “sound speed profile,” which varies with geographic latitude, season, and time of day.

Sound tends to follow many paths through the ocean, so that a listener may hear multiple, delayed copies of transmitted signals (Richardson et al. 1995a). Echoes are a familiar example of this phenomenon in air. In order to determine what the paths of sound transmission are, one rule is to seek paths that deliver the sound to the receiver the fastest. If the speed of sound were constant throughout the ocean, acoustic rays would consist of straight-line segments, with reflections off the surface and the bottom. However, because the speed of sound varies in the ocean, most acoustic rays do not follow a straight path.

As sound travels through the ocean, the intensity associated with the wave front diminishes, or attenuates. In shallow waters of coastal regions and on continental shelves, sound speed profiles become influenced by surface heating and cooling, salinity changes, and water currents. As a result, these profiles tend to be irregular and unpredictable, and contain numerous gradients that last over short time and space scales. This decrease in intensity is referred to as propagation loss, also commonly called transmission loss. In general, in a homogeneous lossless medium, sound intensity decreases as the square of the range due to simple spherical spreading. For example, a source level of 235 dB will have decreased in intensity to a received level of 175 dB after about 914 meters (1,000 yards).

4 RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

Five species/DPSs of marine mammals listed as threatened or endangered under the ESA under NMFS's jurisdiction may occur in the action area. The action area also includes critical habitat for two species. This opinion considers the effects of the proposed action on these species and designated critical habitats (Table 10).

Table 10. Listing status and critical habitat designation for marine mammals considered in this opinion.

Species	Status	Listing	Critical Habitat
Cook Inlet Beluga Whale (*Delphinapterus leucas)*	Endangered	NMFS 2008, 73 FR 62919	2011 76 FR 20180
Fin Whale (*Balaneoptera physalus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Humpback Whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	NMFS 1970, 35 FR 18319 NMFS 2016 81 FR 62260	Not designated
Humpback Whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	NMFS 1970, 35 FR 18319 NMFS 2016 81 FR 62260	Not designated
Steller Sea Lion, Western DPS (*Eumatopias jubatus)*	Endangered	NMFS 1997, 62 FR 24345	1993 58 FR 45269

4.1 Climate Change

One threat is or will be common to all of the species we discuss in this opinion: global climate change. Because of this commonality, we present this narrative here rather than in each of the species-specific narratives that follow.

The timeframe for the proposed action is August 2017 through August 2022, which is a relatively short duration. However, Alaska is experiencing rapid climate change with each new year and is experiencing further decreases in ice cover and extensions of the open-water season.

The Fifth Assessment Synthesis Reports from the Working Groups on the Intergovernmental Panel on Climate Change (IPCC) conclude that climate change is unequivocal (IPCC 2013, 2014). The Report concludes oceans have warmed, with ocean warming the greatest near the surface (e.g., the upper 75 m have warmed by 0.11°C per decade over the period 1971 to 2010) (IPCC 2013, 2014). Global mean sea level rose by 0.19 m between 1901 and 2010, and the rate of sea level rise since the mid-nineteenth century has been greater than the mean rate during the previous 2 millennia (IPCC 2013). The IPCC projects a rise of the world's oceans from 0.26 to 0.98 meters by the end of the century, depending on the level of greenhouse gas emissions (Doney et al. 2012). Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (IPCC 2013, 2014). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2013), and this rise has been linked to climate change (Foreman and Yamanaka 2011, GAO 2014, Murray et al. 2014, Okey et al. 2014, Secretariat of the Convention on Biological Diversity 2014, Andersson et al. 2015). Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, heat waves, and droughts (IPCC 2014). Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future (Bellard et al. 2012). Climate change is also expected to result in the expansion of low oxygen zones in the marine environment (Gilly et al. 2013). Though predicting the precise consequences of climate change on highly mobile marine species, such as many of those considered in this opinion, is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring.

Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012). Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. He predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some species predicted to experience losses. MacLeod (2009) estimated, based upon expected shifts in water temperature, 88 percent of cetaceans would be affected by climate change, with 47 percent likely to be negatively affected.

For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott. 2009). Low reproductive success and body condition in humpback whales may have resulted from the 1997/1998 El Niño, and resulting effects upon humpback prey availability (Cerchio et al. 2005).

Species that are shorter-lived, of larger body size, or generalist in nature are likely to be better able to adapt to climate change over the long term versus those that are longer-lived, smaller-sized, or rely upon specialized habitats (Purvis et al. 2000, Brashares 2003, Cardillo 2003, Cardillo et al. 2005, Issac 2009). Climate change is most likely to have its most pronounced effects on species whose populations are already in tenuous positions (Issac 2009). As such, we expect the risk of extinction to listed species to rise with the degree of climate shift associated with global warming. The limits to acclimatization or adaptation capacity are presently unknown. However, mass extinctions occurring during much slower rates of climate change in Earth history suggest that evolutionary rates in some organisms may not be fast enough to cope (IPCC 2014).

Foraging is not the only aspect that climate change could influence. Acevedo-Whitehouse and Duffus (2009) proposed that the rapidity of environmental changes, such as those resulting from global warming, can harm immunocompetence and reproductive parameters in wildlife to the detriment of population viability and persistence. Altered ranges can also result in the expansion or shift in range of competing species or novel diseases to new areas (Simmonds and Eliott. 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Eliott. 2009).

4.2 Status of Listed Species

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR §402.02. The opinion further examines the condition of critical habitat throughout the designated area, and discusses the current function of the essential PBFs that help to form the conservation value for those listed species.

This section consists of narratives for each of the endangered and threatened species that occur in the action area and that may be adversely affected by the proposed action. In each narrative, we present a summary of information on the population structure and distribution of each species to provide a foundation for the exposure analyses that appear later in this opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether an action's direct and/or indirect effects are likely to increase the species' probability of becoming extinct.

4.3 Cook Inlet Beluga Whale

The endangered Cook Inlet beluga whale is the listed species most likely to be affected by this action, primarily from noise. In this opinion, we focus on aspects of beluga whale ecology that are relevant to the effects of this action.

4.3.1 Description and Status

The beluga whale is a small, toothed (Odontocete) whale in the family Monodontidae, a family shared with only the narwhal. Beluga whales are known as "white whales" because the adults are white. Beluga calves are born dark to brownish gray and lighten to white or yellow-white with age. Adult Cook Inlet beluga whales average between 3.6-4 m (12-14 ft.) in length, although Alaska Native hunters have reported some may grow to 6 m (20 ft.) (Huntington 2000).

A detailed description of the Cook Inlet beluga whales' biology, habitat, and extinction risk factors may be found in the endangered listing final rule for the species (73 FR 62919, October 22, 2008), the Conservation Plan for the Cook Inlet beluga whale (NMFS 2008a), and the Recovery Plan (NMFS 2016d). Additional information regarding Cook Inlet beluga whales can be found on the NMFS AKR web site at:
http://alaskafisheries.noaa.gov/protectedresources/whales/beluga.htm.

The Cook Inlet beluga whale population was estimated at 1,300 whales in 1979 (Calkins 1989), but experienced a dramatic decline in the 1990s (Figure 9). This decline was attributed to over-harvesting by subsistence hunting, which was then estimated to have removed 10 to 15 percent of the population per year. During 1994-1998 the population was documented to decline about 47 percent, from an estimated 653 to 347 whales (Hobbs et al. 2000). After measures were established in 1999 to regulate subsistence harvests, NMFS expected the population to grow at an annual rate of 2 to 6 percent. However, abundance estimates from the 1999-2008 aerial surveys showed the expected population growth did not occur. This led to the ESA listing of the Cook Inlet beluga whale in 2008 (73 FR 62919), and designation of critical habitat in 2011 (76 FR 20180, April 11, 2011). Although only five Cook Inlet beluga whales have been harvested since 1999 and none have been harvested since 2005, the population continues to decline. Data on the incidence of mortality from other sources is scant, precluding us from concluding whether continued population declines are due to increases in mortality or decreases in productivity. The 2014 population abundance estimate was 340 whales, indicating a 10 year decline of 0.4 percent per year (Shelden et al. 2015b). A recent 2016 population estimate is 328 individuals; however, further analyses are required to ascertain a valid population trend (NMFS, MML, Unpublished data, 2017).

4.3.2 Range and Behavior

Cook Inlet beluga whales reside in Cook Inlet year-round, which makes them geographically and genetically isolated from other beluga whale stocks in Alaska (Allen and Angliss 2015). Within Cook Inlet, they generally occur in shallow, coastal waters, often in water barely deep enough to cover their bodies (Ridgway and Harrison 1981). Although beluga whales remain year-round in Cook Inlet, they demonstrate seasonal movements within the inlet. During the summer and fall, beluga whales are concentrated near the Susitna River mouth, Knik Arm, Turnagain Arm, and Chickaloon Bay (Nemeth et al. 2007). During the winter, beluga whales concentrate in deeper waters in the mid-inlet to Kalgin Island, and in the shallow waters along the west shore of Cook Inlet to Kamishak Bay. Some whales may also winter in and near Kachemak Bay.

Beluga whales are extremely social and often interact in close, dense groups. Most calving in Cook Inlet is assumed to occur from mid-May to mid-July (Calkins 1984; NMFS unpublished data). The only known observed occurrence of calving occurred in mid-July, 2015, on the Susitna Delta, although newborn calves have been observed there from July to October (Dr. Tamara McGuire, LGL, Pers. Comm. March 27, 2017). Young beluga whales are nursed for two years and may continue to associate with their mothers for a considerable time thereafter (Reeves et al. 2002).

Beginning in 1993, aerial surveys have been conducted annually or biennially in June and August by NMFS Marine Mammal Laboratory (NMFS 2008a, Hobbs et al. 2011). Historic aerial surveys for beluga whales also were completed in the late 1970s and early 1980s (Harrison and Hall 1978, Murray and Fay 1979, Harza-Ebasco Susitna Joint Venture 1985). Results indicate that prior to the 1990s belugas used areas throughout the upper, mid, and lower Inlet during the spring, summer, and fall (Huntington 2000, Rugh et al. 2000, NMFS 2008a, Rugh et al. 2010a)(Figure 7). The distribution has since contracted northeastward into upper Cook Inlet, which is especially evident in the summer range (Rugh et al. 2000, Speckman and Piatt 2000, Hobbs et al. 2008, NMFS 2008a, Rugh et al. 2010a, Shelden et al. 2015a)(Figure 7).

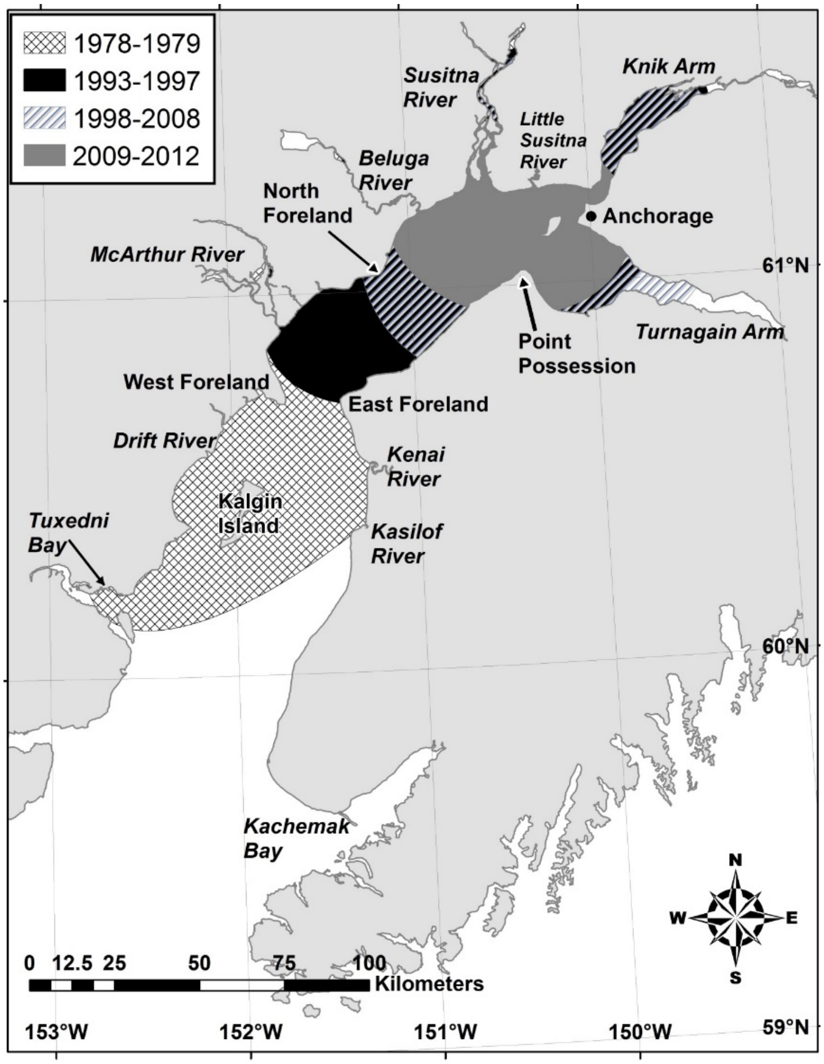


Figure 7. Summer range contraction over time as indicated by ADF&G and NMFS aerial surveys. Adapted from Shelden et al. (2015a).

This distributional shift and contraction coincided with the decline in abundance (Moore et al. 2000, NMFS 2008a, Goetz et al. 2012, NMFS 2015). Groups of over 200 individuals, including adults, juveniles, and neonates, have been observed in the Susitna Delta area alone (McGuire et al. 2014). NMFS refers to this preferred summer-fall habitat near the Susitna Delta as the Susitna Delta Exclusion Zone and seeks to minimize human activity in this area of extreme importance to Cook Inlet beluga whale survival and recovery. Goetz et al. (2012) modeled beluga use in Cook Inlet based on the NMFS aerial surveys conducted between 1994 and 2008. The combined model results indicate that lower densities of belugas are expected to occur in the action area. However, the area between Nikiski, Kenai, and Kalgin Island provides important wintering habitat for Cook Inlet beluga whales. Use of this area would be expected between fall and spring, with animals present at lower densities during the ice-free months when oil and gas exploration surveys would occur (Goetz et al. 2012).

4.3.3 Hearing Ability

Like other odontocete cetaceans, beluga whales produce sounds for two overlapping functions: communication and echolocation. For their social interactions, belugas emit communication calls with an average frequency range of about 0.2 to 7.0 kHz (Garland et al. 2015) (well within the human hearing range), and the variety of audible whistles, squeals, clucks, mews, chirps, trills, and bell-like tones they produce have led to their nickname as sea canaries (ADF&G 2015). At the other end of their hearing range, belugas use echolocation signals (biosonar) with peak frequencies at 40-120 kHz (Au 2000) to navigate and hunt in dark or turbid waters, where vision is limited. Belugas and other odontocetes make sounds across some of the widest frequency bands that have been measured in any animal group.

Even among odontocetes, beluga whales are known to be among the most adept users of sound. It is possible that the beluga whale's unfused vertebrae, and thus the highly movable head, have allowed adaptations for their sophisticated directional hearing. Awbrey et al. (1988) examined their hearing in octave steps between 125 Hz and 8 kHz, and found average hearing thresholds of 121 dB re1 μPa at 125 Hz and 65 dB re 1 μPa at 8 kHz. Johnson et al. (1989), further examining beluga hearing at frequencies between 40 Hz and 125 kHz, found a hearing threshold of 140 dB re 1 μPa at 40 Hz. The lowest measured threshold (81 dB re 1 μPa) was at 4 kHz. Ridgway et al. (2001) measured hearing thresholds at various depths down to 984 ft (298 m) at frequencies between 500 Hz and 100 kHz and found that beluga whales showed unchanged hearing sensitivity at any measured depth. Finneran et al. (2005) described the auditory ranges of two belugas as 2 kHz to 130 kHz. Most of these studies measured beluga hearing in very quiet conditions. However, in Cook Inlet, tidal currents regularly produce ambient sound levels well above 100 dB (Lammers et al. 2013). Belugas' signal intensity can change with location and background noise levels (Au et al. 1985). In the first report of hearing ranges of belugas in the wild, results of Castellote et al. (2014) were similar to those reported for captive belugas, with most acute hearing at middle frequencies, about 10-75 kHz (Figure 8).

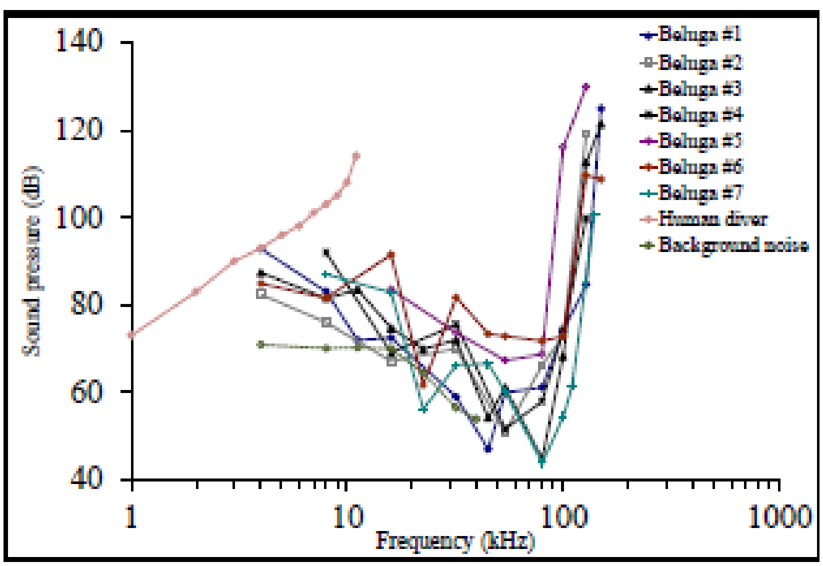


Figure 8. Audiograms of seven wild beluga whales. Human diver audiogram and Bristol Bay background noise for comparison (from Castellote et al. 2014). Results indicate that beluga whales conduct echolocation at relatively high

frequencies, where their hearing is most sensitive, and communicate at frequencies, where their hearing sensitivity overlaps that of humans.

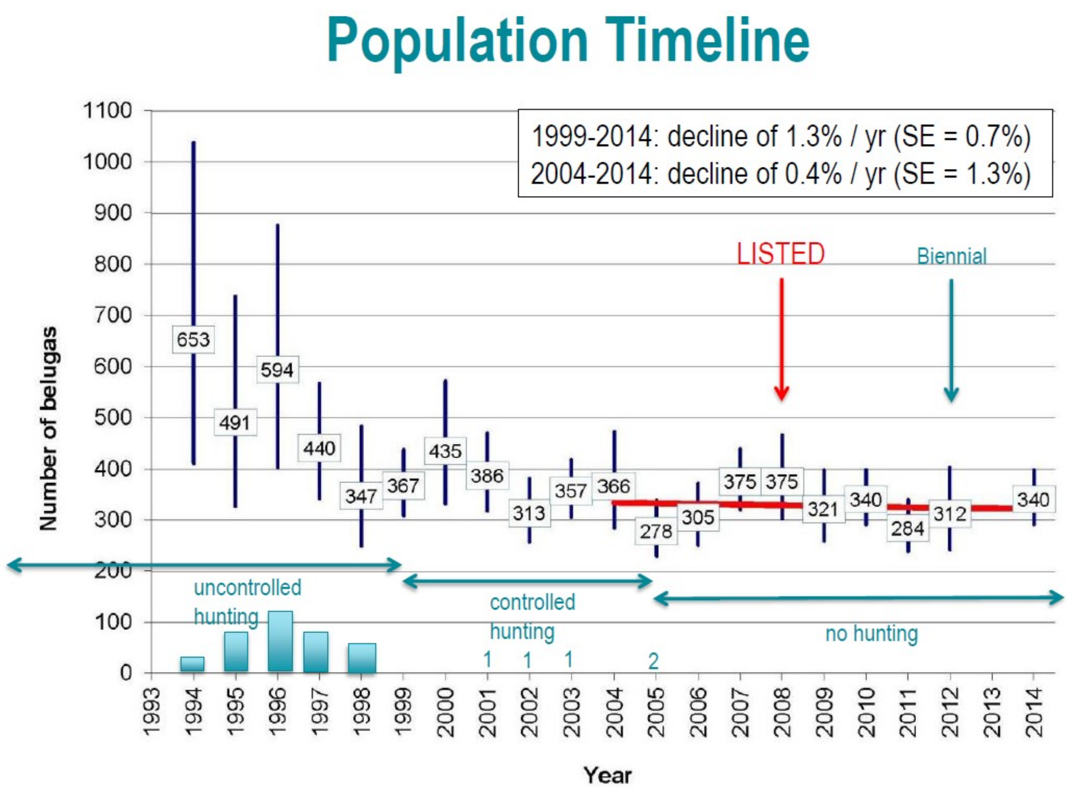


Figure 9. Population of Cook Inlet belugas. Blue bars and numbers along the x axis note known harvests of belugas during each year. Harvest methods used during the 1990's also resulted in many struck and lost belugas (NMFS 2017).

4.3.4 Cook Inlet Beluga Critical Habitat

NMFS designated critical habitat for the Cook Inlet beluga whale on April 11, 2011 (76 FR 20180). NMFS designated two areas as critical habitat (see Figure 9). Area 1 includes all marine waters of Cook Inlet north of a line from the mouth of Threemile Creek (61°08.5' N., 151°04.4' W.) connecting to Point Possession (61°02.1' N., 150°24.3' W.), including waters of the Susitna River south of 61°20.0' N., the Little Susitna River south of 61°18.0' N., and the Chickaloon River north of 60°53.0' N. Area 2 includes all marine waters of Cook Inlet south of a line from the mouth of Threemile Creek (61°08.5' N., 151°04.4' W.) to Point Possession (61°02.1' N., 150°24.3' W.) and north of 60°15.0'N., including waters within 2 nautical miles seaward of MHW along the western shoreline of Cook Inlet between 60°15.0' N. and the mouth of the Douglas River (59°04.0' N., 153°46.0' W.); all waters of Kachemak Bay east of 151°40.0' W.; and waters of the Kenai River below the Warren Ames bridge at Kenai, Alaska. NMFS excluded all waters off the Port of Anchorage east of a line connecting Cairn Point (61°15.4'N., 149° 52.8'W.) and Point MacKenzie (61°14.3'N., 149° 59.2'W.) and north of a line connecting Point MacKenzie and the north bank of the mouth of Ship Creek (61°13.6'N., 149° 53.8'W) (Figure 10). The action area is located within designated Cook Inlet beluga critical habitat (specifically, critical habitat Area 2).

The Cook Inlet Beluga Whale Critical Habitat Final Rule (76 FR 20180, 20214) included designation of five Primary Constituent Elements (PCEs, referred to in this opinion as PBFs). These 5 PBFs were deemed essential to the conservation of the Cook Inlet beluga whale. The PBFs are:

1. Intertidal and subtidal waters of Cook Inlet with depths <30 feet (MLLW) and within five miles of high and medium flow anadromous fish streams.

2. Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.

3. Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.

4. Unrestricted passage within or between the critical habitat areas.

5. Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.

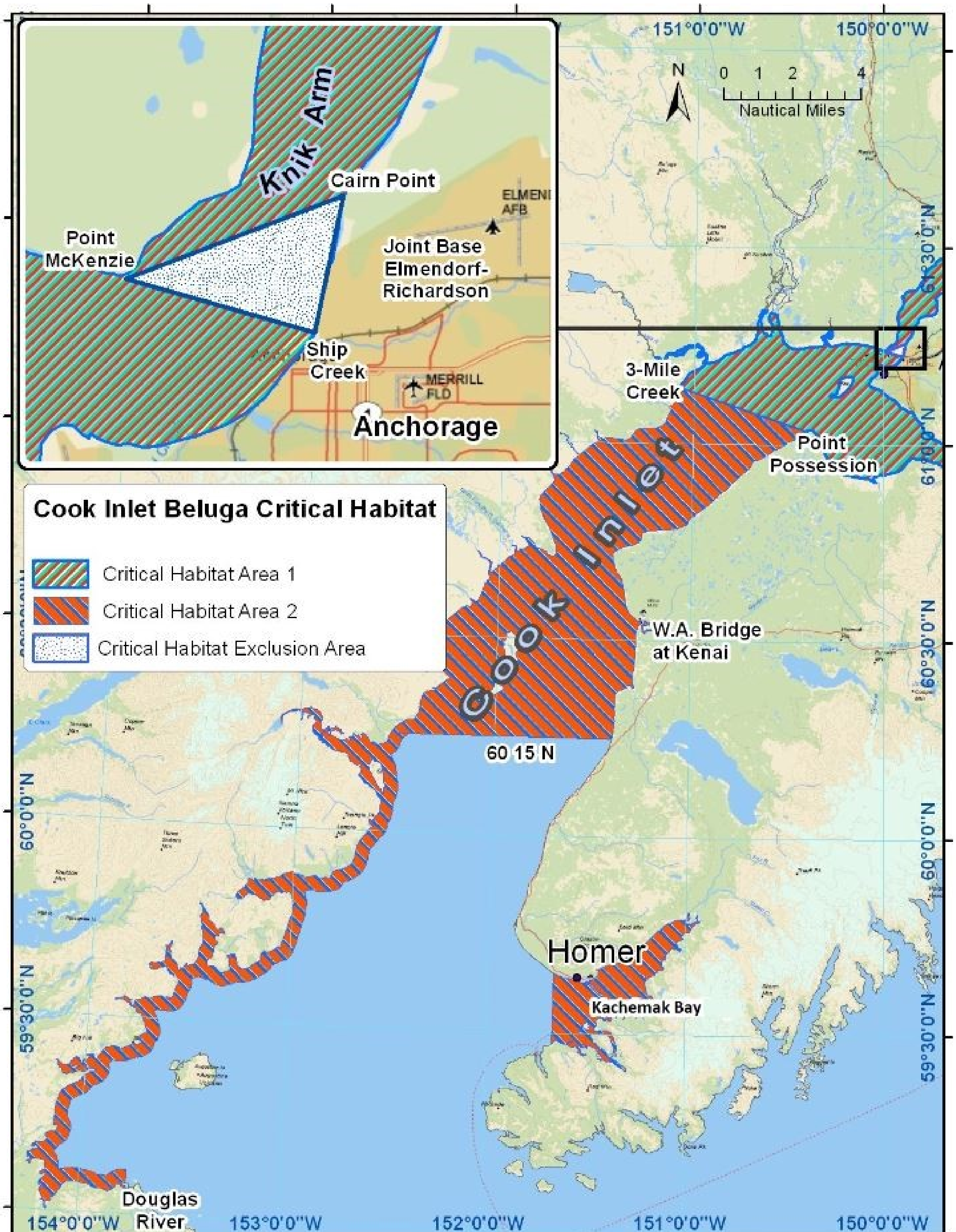


Figure 10. Critical Habitat for Cook Inlet beluga whales.

Critical Habitat Area 1 (Figure 10; green hashed area) is located in the northernmost region of Cook Inlet and consists of shallow tidal flats, river mouths, and estuarine areas. Area 1 is important as foraging and calving habitats, and beluga whales are concentrated in Area 1 during spring and summer months for these purposes. Area 1 also has the highest concentrations of beluga whales from spring through fall (approximately March through October), as well as the greatest potential for adverse impact from anthropogenic threats.

Critical habitat Area 2 was designated for the area's importance to fall and winter feeding and transit. Area 2 includes the Cook Inlet waters south of Area 1 habitat, as well as Kachemak Bay and foraging areas along the western shore of lower Cook Inlet (Figure 10). The LS 244 area will occur near the southern boundary of the Area 2 of Cook Inlet beluga whale critical habitat that is primarily used by Cook Inlet belugas during the fall and winter months. Based on dive behavior and analysis of stomach contents from Cook Inlet belugas, it is assumed that Area 2 habitat is an active feeding area during fall and winter months when the spatial dispersal and diversity of winter prey likely influences the wider beluga winter range (NMFS 2008a). However, tagging data indicate use of Area 2 by belugas in all months except April and May, and the indicated absence of use of Area 2 in April and May is based upon tagging data from only 2 whales (MML unpublished data, April, 2017).

According to the preferred alternative in BOEM (2017a), seismic surveys will not occur on any OCS block in the LS 244 area between November 1 and April 1, nor will both exploration and delineation drilling and geohazard and geotechnical surveys occur on the 10 LS 244 OCS blocks within Cook Inlet beluga whale critical habitat between November 1 and April 1, which provides protection during with the fall and winter months when Area 2 of the critical habitat is primarily used by Cook Inlet beluga whales. In addition, seismic surveys will not occur on LS 244 OCS blocks within 10 miles of nearshore feeding areas associated with anadromous streams between July 1 and September 30, when beluga whales may be present and foraging along those nearshore areas on anadromous fish.

Cook Inlet beluga whales may be affected by a number of natural and manmade factors present in the Action Area. Many of these factors also have the potential to affect PBFs of Cook Inlet beluga whale critical habitat. Natural threats to critical habitat include environmental variability, catastrophic events, competition for prey resources, and exposure to naturally occurring toxins (e.g., HABs). Anthropogenic threats to critical habitat include: 1) reductions in prey due to competition with fisheries; and 2) habitat loss or degradation resulting from exposure to toxic substances, presence of anthropogenic noise, continued coastal development, and presence of vessel traffic and tourism. These threats may occur individually or collectively (NMFS 2016d), and may affect essential physical and biological features of their designated critical habitats that are essential to their conservation.

Although belugas may have abandoned critical habitat off of the Kenai River during the peak periods of large salmon runs (see Figure 25), they make heavy use of salmon runs elsewhere in Upper Cook Inlet, most notably using waters near the mouth of the Susitna and Beluga rivers, and rivers feeding into Knik Arm and Chickaloon Bay (Goetz et al. 2012). Salmon returns in Cook Inlet drainages remain strong, but fewer salmon runs may be available to belugas due to anthropogenic activity. Little information is available on salmon returns to those drainages most heavily exploited by Cook Inlet beluga whales, although limited salmon return counts for the Little Susitna River for Chinook, sockeye, and coho salmon since 1988 suggest no clear trend (http://www.alaskaoutdoorssupersite.com/salmon-run-charts).

Threats to Cook Inlet beluga whale critical habitat are discussed in section 4.10.

4.4 Fin Whale

Following large scale population declines from commercial whaling, NMFS listed fin whales as endangered in 1970 under the Endangered Species Conservation Act (ESCA), a precursor to the ESA (35 FR 18319, December 2, 1970). This listing status was retained when the ESA superseded the ESCA in 1973. The Alaska stock is listed as “depleted” under the MMPA and categorized as a strategic stock (Allen and Angliss 2015). No critical habitat has been designated for the fin whale. A Final Recovery Plan for the Fin Whale (*Balaenoptera physalus*) was published on July 30, 2010 (NMFS 2010e).

4.4.1 Description and Status

It is difficult to assess the current status of fin whales because (1) there is no general agreement on the size of the fin whale population prior to whaling and (2) estimates of the current size of the different fin whale populations vary widely. Prior to exploitation by commercial whalers, fin whales are thought to have numbered greater than 464,000 worldwide, and are now thought to number approximately 119,000 worldwide (Braham 1991). As used in this opinion, “populations” are isolated demographically, meaning, they are driven more by internal dynamics — birth and death processes — than by the geographic redistribution of individuals through immigration or emigration. Some usages of the term “stock” are synonymous with this definition of “population” while other usages of “stock” are not. To note, because the listing does not distinguish between stocks (or DPSs), all fin whale stocks are listed as endangered under the ESA.

Fin whales have two recognized subspecies: *B. p. physalus* occurs in the North Atlantic Ocean (Gambell 1985), while *B. p. quoyi* occurs in the Southern Ocean (Fischer 1829). Most experts consider the North Pacific fin whales a separate unnamed subspecies.

The International Whaling Commission (IWC) recognizes several management units or “stocks” of fin whales in the North Atlantic Ocean and in U.S. Pacific waters. In the North Atlantic Ocean, the IWC recognizes seven management units or “stocks” of fin whales: (1) Nova Scotia, (2) Newfoundland-Labrador, (3) West Greenland, (4) East Greenland-Iceland, (5) North Norway, (6) West Norway-Faroe Islands, and (7) British Isles-Spain-Portugal. In addition, the population of fin whales that resides in the Ligurian Sea, in the northwestern Mediterranean Sea, is believed to be genetically distinct from other fin whales populations In U.S. Pacific waters, the IWC recognizes three “stocks”: (1) Alaska (Northeast Pacific), (2) California/Washington/Oregon, and (3) Hawaii (Allen and Angliss 2015). However, Mizroch et al. (2009) suggests that this structure should be reviewed and updated, if appropriate, to reflect current data that suggests there may be at least 6 populations of fin whales in this region.

Ohsumi and Wada (1974) estimated that the North Pacific fin whale population ranged from 42,000-45,000 before whaling began. Dedicated line transect cruises were conducted in coastal waters of western Alaska and the eastern and central Aleutian Islands in July-August 2001-2003 (Zerbini et al. 2009). Fin whale sightings (n = 276) were observed from east of Kodiak Island to Samalga Pass, with high aggregations recorded near the Semidi Islands. Zerbini et al. (2006) estimated that 1,652 (95 percent CI: 1,142-2,389) whales occurred in the area. An annual increase of 4.8 percent (95 percent CI: 4.1-5.4 percent) was estimated for the period of 1987-2003 (Allen and Angliss 2015).

The best estimate of the fin whale population west of the Kenai Peninsula is 1,368, the greater minimum estimates from the 2008 and 2010 surveys (Friday et al. 2013).

The minimum estimate for the California/Oregon/Washington stock, as defined in the U.S. Pacific Marine Mammal Stock Assessments, was about 2,316 during 2008 (Carretta et al. 2009). Available survey data suggest an increasing trend between 1979/80 and 1993, but that trend was not statistically significant (Barlow et al. 1997).

The minimum population estimate for the Western North Atlantic stock of fin whales is 2,269 (NMFS 2010e), however, data from 1966-1982 indicate that about 1,500 fin whales occur in the western North Atlantic between Nova Scotia and North Carolina during winter, while 5,000 occurred there during summer (Hain et al. 1992). Data quality precludes one from concluding whether this difference in abundance over time reflects a population trend.

A compilation of estimates throughout their range suggest that the global population of fin whales is in the tens of thousands, with the North Pacific population numbering at least 5,000 individuals. The number of fin whales that are reported to have been killed or injured in the past 20 years by human activities or natural phenomena does not appear to be increasing their probability of extinction, although it may be slowing the recovery rate.

4.4.2 Range and Behavior

Fin whales are distributed widely in every ocean except the Arctic Ocean (where they have only recently begun to appear). In the North Pacific Ocean, fin whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the Gulf of Alaska (Gambell 1985). They do not overwinter in the action area.

Recent information on seasonal fin whale distribution has been gleaned from the reception of fin whale calls by bottom-mounted, offshore hydrophone arrays along the U.S. Pacific coast, in the central North Pacific, and in the western Aleutian Islands (Moore et al. 1998, Watkins et al. 2000, Moore et al. 2006, Stafford et al. 2007, Širović et al. 2013, Soule and Wilcock 2013). Moore et al. (1998, 2006), Watkins et al. (2000), and Stafford et al. (2007) all documented high levels of fin whale call rates along the U.S. Pacific coast beginning in August/September and lasting through February, suggesting that these may be important feeding areas during the winter. Fin whales have been acoustically detected in the Gulf of Alaska year-round, with highest call occurrence rates from August through December and lowest call occurrence rates from February through July (Moore et al. 2006, Stafford et al. 2007). However, fin whale sightings in Cook Inlet are rare. During the NMFS aerial surveys in 2001 through 2014, a total of nine groups (27 individuals) were reported, all of which were south of Kachemak Bay. Ferguson et al. (2015a), identified areas around Kodiak Island as a Biologically Important Area for fin whale feeding (Figure 11). Portions of this Biologically Important Area are within the action area.

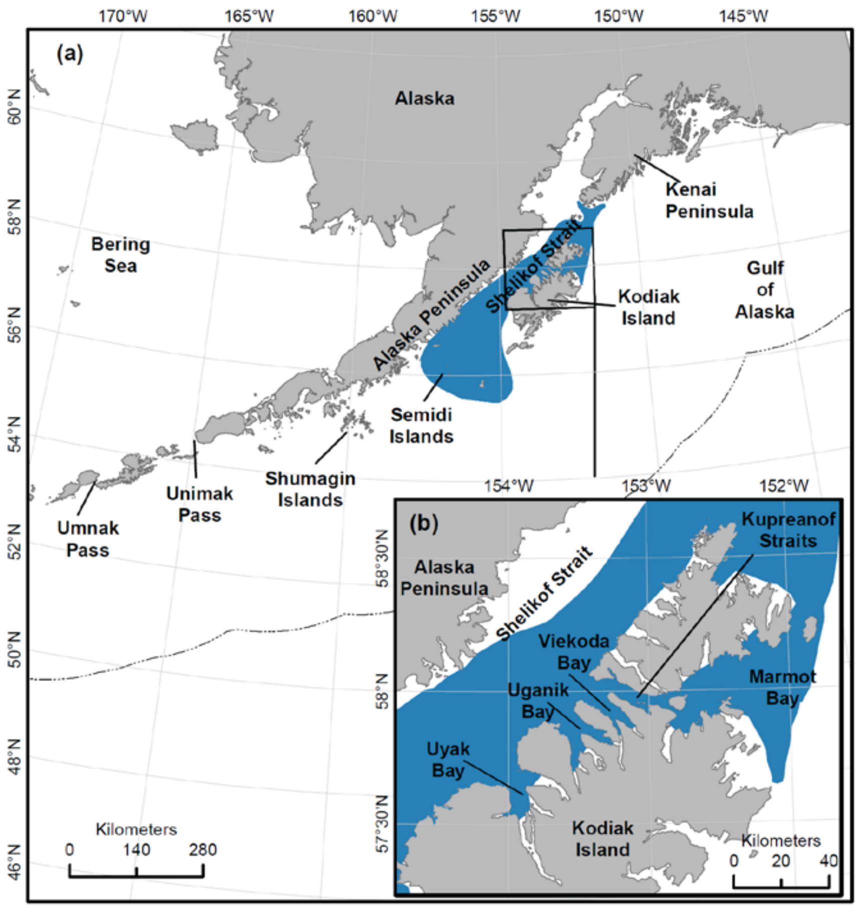


Figure 11. Fin whale Biologically Important Area for feeding identified by Ferguson et al. (2015) around Kodiak Island in the Gulf of Alaska.

In the North Pacific overall, fin whales prefer euphausiids (mainly *Euphausia pacifica*, *Thysanoessa longipes*, *T. spinifera*, and *T. inermis*) and large copepods (mainly *Calanus cristatus*), followed by schooling fish such as herring, walleye pollock (*Theragra chalcogramma*), and capelin (Nemoto 1970, Kawamura 1982).

A migratory species, fin whales generally spend the spring and early summer feeding in cold, high latitude waters as far north as the Chukchi Sea, with regular feeding grounds in the Gulf of Alaska, Prince William Sound, along the Aleutian Islands, and around Kodiak Island, primarily on the western side. In the fall, fin whales tend to return to low latitudes for the winter breeding season, though some may remain in residence in their high latitude ranges if food resources remain plentiful. In the eastern Pacific, fin whales typically spend the winter off the central California coast and into the Gulf of Alaska. Panigada et al. (2006) found water depth to be the most significant variable in describing fin whale distribution, with more than 90 percent of sightings occurring in waters deeper than 2,000 m.

Feeding may occur in waters as shallow as 10 m when prey are at the surface, but most foraging is observed in high-productivity, upwelling, or thermal front marine waters (Gaskin 1972, Sergeant 1977, Nature Conservancy Council 1979 as cited in ONR 2001, Panigada et al. 2008).

The percentage of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5-20 shallow dives with each of these dive lasting 13-20 seconds followed by a deep dive lasting between 1.5 and 15 minutes (Gambell 1985, Stone et al. 1992, Lafortuna et al. 2003). Other authors have reported that the fin whale's most common dives last between 2 and 6 minutes, with 2 to 8 blows between dives (Watkins 1981, Hain et al. 1992). The most recent data support average dives of 98 m and 6.3 min for foraging fin whales, while non-foraging dives are 59 m and 4.2 min (Croll et al. 2001). However, Lafortuna *et al.* (1999) found that foraging fin whales have a higher blow rate than when traveling. Foraging dives in excess of 150 m are known (Panigada et al. 1999). In waters off the U.S. Atlantic Coast, individuals or duos represented about 75 percent of sightings during the Cetacean and Turtle Assessment Program (Hain et al. 1992). Barlow (2003) reported mean group sizes of 1.1–4.0 during surveys off California, Oregon, and Washington.

There is considerable variation in grouping frequency by region. In general, fin whales, like all baleen whales, are not very socially organized, and most fin whales are observed as singles. Fin whales are also sometimes seen in social groups that can number 2 to 7 individuals. However, up to 50, and occasionally as many as 300, can travel together on migrations (NMFS 2010e). Fin whales in the Cook Inlet have only been observed as individuals or in small groups.

4.4.3 Vocalizations and Hearing

The sounds fin whales produce underwater are one of the most studied *Balaenoptera* sounds. Fin whales produce a variety of low-frequency sounds in the 10-200 Hz band (Watkins 1981, Watkins et al. 1987, Edds 1988, Thompson et al. 1992). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels for fin whales are 140-200 dB re 1 µPa m (Patterson and Hamilton 1964, Watkins et al. 1987, Thompson et al. 1992, McDonald et al. 1995, Clark and Gagnon 2004). In temperate waters intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clark and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald et al. 1995), Clark personal communication, McDonald personal communication). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999).

During the breeding season, fin whales produce a series of pulses in a regularly repeating pattern. These bouts of pulsing may last for longer than one day (Tyack 1999). The seasonality and stereotype of the bouts of patterned sounds suggest that these sounds are male reproductive displays (Watkins et al. 1987), while the individual counter calling data of McDonald et al. (1995) suggest that the more variable calls are contact calls. Some authors feel there are geographic differences in the frequency, duration, and repetition of the pulses (Thompson et al. 1992).

As with other vocalizations produced by baleen whales, the function of fin whale vocalizations is unknown, although there are numerous hypotheses (which include: maintenance of inter-individual distance, species and individual recognition, contextual information transmission, maintenance of social organization, location of topographic features, and location of prey resources; see the review by (Thompson et al. 1992) for more information on these hypotheses). Responses to conspecific sounds have been demonstrated in a number of mysticetes, and there is no reason to believe that fin whales do not communicate similarly (Edds-Walton 1997). The low-frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long-distance communication occurs in fin whales (Payne and Webb 1971, Edds-Walton 1997). Also, there is speculation that the sounds may function for long-range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack 1999).

While there is no direct data on hearing in low-frequency cetaceans, the applied frequency range is anticipated to be between 7 Hz to 35 kHz (NMFS 2016f).

Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic (low pitch) hearing. Synthetic audiograms produced by applying models to X-ray computed tomography scans of a fin whale calf skull indicate the range of best hearing for fin whale calves to range from approximately 0.02 to 10 kHz, with maximum sensitivities between 1 to 2 kHz (Cranford and Krysl 2015).

4.5 Western North Pacific DPS and Mexico DPS Humpback Whale

The humpback whale was listed as endangered under the Endangered Species Conservation Act (ESCA) on December 2, 1970 (35 FR 18319). Congress replaced the ESCA with the ESA in 1973, and humpback whales continued to be listed as endangered. NMFS recently conducted a global status review and changed the status of humpback whales under the ESA. The Western North Pacific (WNP) DPS (which includes a small proportion of humpback whales found in the action area) is listed as endangered; the Mexico DPS (which includes a small proportion of humpback whales found in the action area) is listed as threatened; and the Hawaii DPS (which includes most humpback whales found in the action area) is not listed (81 FR 62260; September 8, 2016). Critical habitat has not been designated for the Western North Pacific or Mexico DPSs.

The abundance estimate for humpback whales in the Gulf of Alaska is estimated to be 2,089 (CV=0.09) animals, which includes whales from the Hawaii DPS (89 %), Mexico DPS (10.5 %), and Western North Pacific DPS (0.5 %[10]) (NMFS 2016c, Wade et al. 2016) (Table 11). Humpback whales occur throughout the central and western Gulf of Alaska from Prince William Sound to the Shumagin Islands. Seasonal concentrations are found in coastal waters of Prince William Sound, Barren Islands, Kodiak Archipelago, Shumagin Islands, and south of the Alaska Peninsula. Large numbers of humpbacks have also been reported in waters over the continental shelf, extending up to 100 nm offshore in the western Gulf of Alaska (Wade et al. 2016).

The Western North Pacific DPS is comprised of approximately 1,059 animals (CV=0.08) (Wade et al. 2016). The population trend for the Western North Pacific DPS is unknown. Humpback whales in the Western North Pacific DPS remain rare in some parts of their former range, such as the coastal waters of Korea, and have shown little signs of recovery in those locations. The

[10] For endangered Western North Pacific DPS we chose the upper limit of the 95% confidence interval from the Wade et al. (2016) estimate in order to be conservative due to their status.

Mexico DPS is threatened, and is comprised of approximately 3,264 animals (CV=0.06) (Wade et al. 2016) with an unknown, but likely declining, population trend (81 FR 62260). The Hawaii DPS is not listed under the ESA, and is comprised of 11,398 animals (CV=0.04). The annual growth rate of the proposed Hawaii DPS was estimated to be between 5.5 and 6.0 percent.

Whales from these three DPSs overlap on feeding grounds off Alaska, and are visually indistinguishable. All waters off the coast of Alaska may contain ESA-listed humpbacks.

Table 11. Probability of encountering humpback whales from each DPS in the North Pacific Ocean (columns) in various feeding areas (on left). Adapted from Wade et al. (2016).

Summer Feeding Areas	**North Pacific Distinct Population Segments**			
	Western North Pacific DPS (endangered)[1]	Hawaii DPS (not listed)	Mexico DPS (threatened)	Central America DPS (endangered)[1]
Kamchatka	100%	0%	0%	0%
Aleutian I/Bering/Chukchi	4.4%	86.5%	11.3%	0%
Gulf of Alaska	0.5%	89%	10.5%	0%
Southeast Alaska / Northern BC	0%	93.9%	6.1%	0%
Southern BC / WA	0%	52.9%	41.9%	14.7%
OR/CA	0%	0%	89.6%	19.7%

[1] For the endangered DPSs, these percentages reflect the 95% confidence interval of the probability of occurrence in order to give the benefit of the doubt to the species and to reduce the chance of underestimating potential takes.

4.5.1 Distribution

Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they reproduce and give birth to calves) and cooler, temperate or sub-Arctic waters in summer months (where they feed). In their summer foraging areas and winter calving areas, humpback whales tend to occupy shallower, coastal waters; during their seasonal migrations; however, humpback whales disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley 1985).

In recent years, humpback whales have been regularly observed in lower and mid Cook Inlet, especially in the vicinity of Elizabeth Island, Iniskin and Kachemak Bays, and north of Anchor Point (Shelden et al. 2013). Of a total 83 humpback whales observed by NMFS during Cook Inlet beluga aerial surveys conducted from 1993-2012, only 5 were observed as far north as the Anchor Point area (Shelden et al. 2013) (Figure 12), which is within the action area.

Humpback whales have been known to occur within the Gulf of Alaska primarily in summer and fall, migrating to southerly breeding grounds in winter and returning to the north in spring

(Calambokidis et al. 2008). However, based on recordings from moored hydrophones deployed in six locations in the Gulf of Alaska from October 1999 to May 2002, humpback calls were most commonly detected during the fall and winter (Stafford et al. 2007).

Marine mammal observers during the 2013 marine mammal monitoring program at Cosmopolitan State well site #A-1 (8 mi [13 km] north of Anchor point in state waters adjacent to the LS 244 area) reported 29 sightings of 48 humpback whales, although most of these animals were observed at a distance well south of the well site, and none were recorded inside an active harassment zone for that project (Owl Ridge 2014). Similarly, Shelden et al. (2015b) observed four humpbacks, all in lower Cook Inlet, during June 2014 beluga aerial surveys (Figure 12). During the 2014 Apache seismic surveys occurring throughout State waters of Cook Inlet north of LS 244, a total of five groups (six individuals) were spotted by the marine mammal observers (Lomac-MacNair et al. 2014). Two humpbacks were observed in May and June, 2015, during marine mammal monitoring from Furie's gas platform the Julius R., located about 10 mi [16 km] south of Tyonek, north of the action area (Jacobs Engineering 2017). Additional opportunistic sightings of a single humpback (or mother-calf pair) in the vicinity of Turnagain Arm, in upper Cook Inlet, was reported in 2014 (NMFS 2016a). Shortly thereafter, a dead humpback, likely the same animal, was found in the same area, suggesting that this anomalous animal may have entered the area in a compromised state. In 2016, one humpback whale stranded in Turnagain Arm near Hope (NMFS unpublished data).

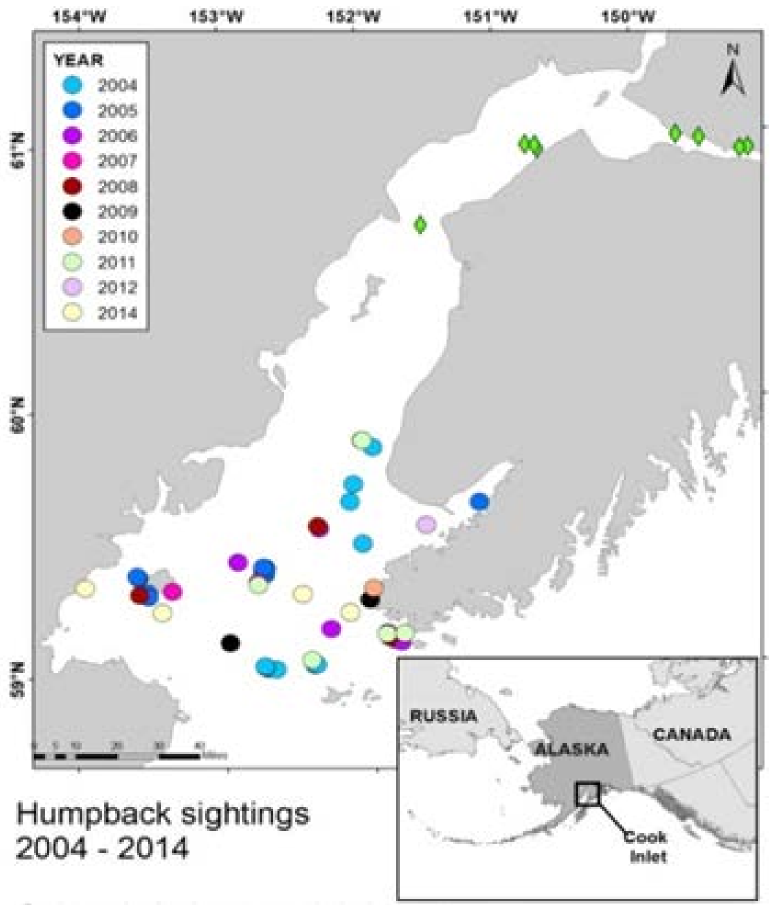


Figure 12. **Humpback whale observations, as documented in Cook Inlet, 1994-2014. Green diamonds indicate opportunistic (and anomalous) sightings of a single whale, or possibly of an adult whale and calf, during April 25-May 1, 2014. Map created 3/12/2015 by Linda Vate Brattstrom, Marine Mammal Lab, NMFS, NOAA.**

Based on both sighting data and acoustic detections, some humpback whales are known to occur year-round in the Gulf of Alaska, although they occur in higher numbers during summer (Stafford et al. 2007, Baumann-Pickering et al. 2012, Debich et al. 2013). Humpback whale occurrence in the action area during the summer time period is considered likely. Ferguson et al. (2015a) identified areas around Kodiak Island, partially within the action area, as a Biologically Important Area for humpback whale feeding (Figure 13).

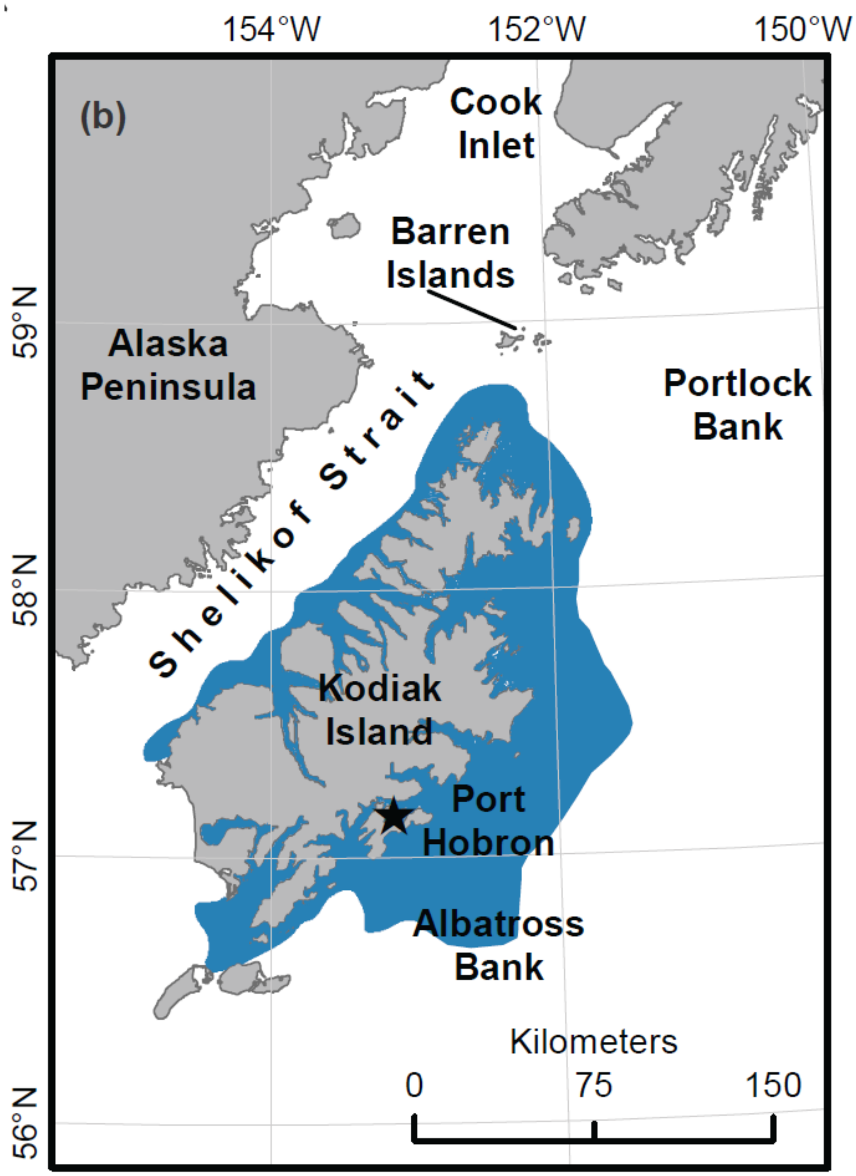


Figure 13. Humpback whale feeding area identified by Ferguson et al. (2015) around Kodiak Island in the Gulf of Alaska. The feeding area occurs northwest of the TMAA.

4.5.2 Vocalizations and Hearing

Humpback whales produce a variety of vocalizations ranging from 20 Hz to 10 kHz (Winn et al. 1970b, Tyack and Whitehead 1983b, Payne and Payne 1985, Silber 1986c, Thompson et al. 1986a, Richardson et al. 1995b, Au 2000, Frazer and Mercado III 2000, Erbe 2002a, Au et al. 2006b, Vu et al. 2012). NMFS categorizes humpback whales in the low-frequency cetacean functional hearing group, with an applied frequency range between 7 Hz and 35 kHz (NMFS 2016f).

During the breeding season males sing long, complex songs, with frequencies in the 20-5000 Hz range and intensities as high as 181 dB (Payne 1970, Winn et al. 1970a, Thompson et al. 1986b).

Source levels average 155 dB and range from 144 to 174 dB (Thompson et al. 1979). The songs appear to have an effective range of approximately 10 to 20 km. Animals in mating groups produce a variety of sounds (Tyack 1981, Silber 1986b).

Social sounds in breeding areas associated with aggressive behavior in male humpback whales are very different than songs and extend from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz (Tyack and Whitehead 1983c, Silber 1986a). These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983c).

Humpback whales produce sounds less frequently in their summer feeding areas. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 seconds and source levels of 175-192 dB (Thompson et al. 1986b). These sounds are attractive and appear to rally animals to the feeding activity (D'Vincent et al. 1985, Sharpe and Dill 1997).

In summary, humpback whales produce at least three kinds of sounds:

1. Complex songs with components ranging from at least 20 Hz–5 kHz with estimated source levels from 144–174 dB; these are mostly sung by males on the breeding grounds (Winn et al. 1970b, Richardson et al. 1995a, Au 2000, Frazer and Mercado 2000, Au et al. 2006a);
2. Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983a, Richardson et al. 1995a); and
3. Feeding area vocalizations that are less frequent, but tend to be 20 Hz–2 kHz with estimated sources levels in excess of 175 dB re 1 Pa at 1m (Thompson et al. 1986a, Richardson et al. 1995a).

Additional information on humpback whale biology and natural history is available at:
http://www.nmfs.noaa.gov/pr/species/mammals/whales/humpback-whale.html
http://alaskafisheries.noaa.gov/pr/humpback
http://www.fisheries.noaa.gov/pr/sars/pdf/stocks/alaska/2015/ak2015_humpback-cnp.pdf

4.6 Western DPS Steller Sea Lions

Western DPS Steller sea lions occur in the action area, but in very low numbers (on the order of a few animals reported per year, and often no animals reported in a given year). We focus in this opinion on aspects of western DPS Steller sea lion ecology that are relevant to the effects of this action.

4.6.1 Description and Status

Steller sea lions belong to the family Otariidae, which includes fur seals (*Callorhinus ursinus*). Steller sea lions are the largest otariid and show marked sexual dimorphism with males 2-3 times larger than females. On average, adult males weigh 566 kg (1,248 lbs.) and adult females are much smaller, weighing on average 580 lbs (Fiscus 1961, Calkins and Pitcher 1982b, Winship et al. 2001).

The Steller sea lion was listed as a threatened species under the ESA on November 26, 1990 (55 FR 49204). In 1997, NMFS reclassified Steller sea lions as two DPSs based on genetic studies and other information (62 FR 24345; May 5, 1997). At that time, the eastern DPS was listed as threatened, and the western DPS was listed as endangered. On November 4, 2013, the eastern DPS was removed from the endangered species list (78 FR 66140). The western DPS remains listed as endangered. Information on Steller sea lion biology, threats, and habitat (including critical habitat) is available online at: http://alaskafisheries.noaa.gov/protectedresources/stellers/default.htm and in the revised Steller Sea Lion Recovery Plan (NMFS 2008b), which can be accessed at: http://alaskafisheries.noaa.gov/protectedresources/stellers/recovery/sslrpfinalrev030408.pdf .

Numbers of Steller sea lions declined dramatically throughout much of the species' range, beginning in the mid- to late 1970s (Braham et al. 1980, Merrick et al. 1987, NMFS 1992, 1995). For two decades prior to the decline, the estimated total population was 250,000 to 300,000 animals (Kenyon and Rice 1961, Loughlin et al. 1984). The population estimate declined by 50-60 percent to about 116,000 animals by 1989 (NMFS 1992), and by an additional 15 percent by 1994, with the entire decline occurring in the range of the western DPS.

The 2016 Stock Assessment Report for the western DPS of Steller sea lions indicates a minimum population estimate of 50,983 individuals (Muto et al. 2017a). The population trend of non-pup western DPS Steller sea lions from 2000-2015 varies regionally, from -8.71 percent per year in the Western Aleutians to +5.07 percent per year in the eastern Gulf of Alaska. Despite incomplete surveys conducted in 2006 and 2007, the available data indicate that the western Steller sea lion DPS has at least been stable since 2004 (when the last complete assessment was done), although declines continue in the western Aleutian Islands. Overall, the western DPS Steller sea lion population both pup and non-pup was estimated to be increasing at about 2 % per year from 2000-2015 (Muto et al. 2017a). In the region of this project (152°-154°), the population of non-pups is increasing at 2.68% per year, while the number of pups counted are increasing at 2.82 % per year.

4.6.2 Distribution

The range of the Steller sea lion extends across the rim of the North Pacific Ocean, from northern Japan, the Kuril Islands, and the Okhotsk Sea, through the Aleutian Islands and Bering Sea, along Alaska's southern coast, and as far south as the California Channel Islands (NMFS 2008c). The eastern DPS includes sea lions born on rookeries from California north through Southeast Alaska; the western DPS includes those animals born on rookeries from Prince William Sound westward, with an eastern boundary set at 144°W (Figure 14).

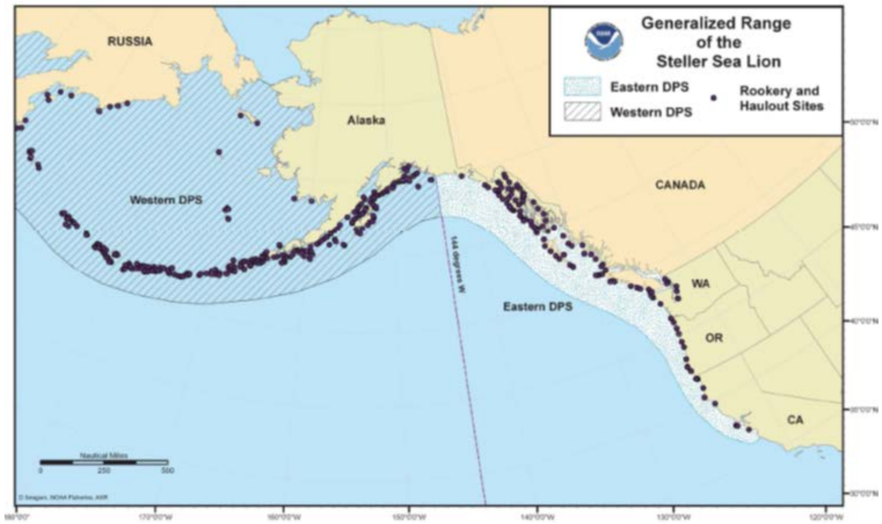


Figure 14. Generalized range of the Steller Sea Lion.

All Steller sea lions in the action area are expected to belong to the western DPS.

The most recent available counts of western DPS Steller sea lions observed on rookeries and haulouts within the action area (from 2015) are shown in Table 12, with the location of these sites shown in Figure 17. About 3,600 sea lions use terrestrial sites in the action area, with additional individuals venturing into the area to forage.

Table 12. **2015 breeding season aerial survey counts of Steller sea lion non-pups and pups within the action area for BOEM Lease Sale 244. Source: Fritz et al. 2015.**

Surveyed Sites Within Action Area	Non-Pups	Pups	Surveyed Sites Within Action Area	Non-Pups	Pups
Gore Point	0		Cape Douglas	0	
East Chugach	0		Kodiak/Malina Point	0	
Perl	44	0	Shaw	0	
Perl Rocks	0		Noisy	0	
Nagahut Rocks	22	0	Shakun Rocks	98	7
Elizabeth/Cape Elizabeth	0		Kodiak/Cape Ugat	150	1
Afognak/Tonki Cape	0		Kodiak/Bird Rock	0	
Flat	0		Kodiak/Cape Kuliuk	0	
West Amatuli	0		Cape Nukshak	0	
Sugarloaf	975	902	Cape Ugyak	0	
Sea Otter/Rk Near	0		Cape Gull	87	0
Sud	0		Cape Kuliak	0	
Sea Otter	119	2	Kodiak/Cape Uyak	0	
Ushagat/Nw	2	0	Takli	24	0
Ushagat/Rocks South	62	0	Kodiak/Sturgeon Head	0	
Ushagat/Sw	220	126	Kodiak/Cape Ikolik	210	0
Latax Rocks	394	16	Kodiak/Tombstone Rocks	0	

Kodiak/Cape Paramanof	0		Puale Bay	124	0
Kodiak/Steep Cape	38	0	**Total Counts**	**2,569**	**1,054**

4.6.3 Diving, Hauling out, Social Behavior

Steller sea lions tend to make shallow dives of less than 250 meters (820 feet) but are capable of deeper dives (NMFS 2008c). Female foraging trips during winter tend to be longer in duration and farther from shore (130 kilometers), during which foraging dives are deeper (frequently greater than 250 meters). Summer foraging dives, on the other hand, tend to be closer to shore (about 16 kilometers) and shallower (100-250 meters) (Merrick and Loughlin 1997). Adult females stay with their pups for a few days after birth before beginning a regular routine of alternating foraging trips at sea with nursing their pups on land. Female Steller sea lions use smell and distinct vocalizations to recognize and create strong social bonds with their newborn pups.

Steller sea lions do not migrate, but they often disperse widely outside of the breeding season (Loughlin 1997). Because of their polygynous breeding behavior, in which individual, adult male sea lions will breed with a large number of adult females, Steller sea lions have clearly-defined social interactions. Steller sea lions are gregarious animals that often travel or haul out in large groups of up to 45 individuals (Keple 2002). At sea, groups usually consist of females and subadult males as adult males are usually solitary (Loughlin 2002). King (1983) reported rafts of several hundred Steller sea lions adjacent to haulouts.

4.6.4 Vocalizations and Hearing

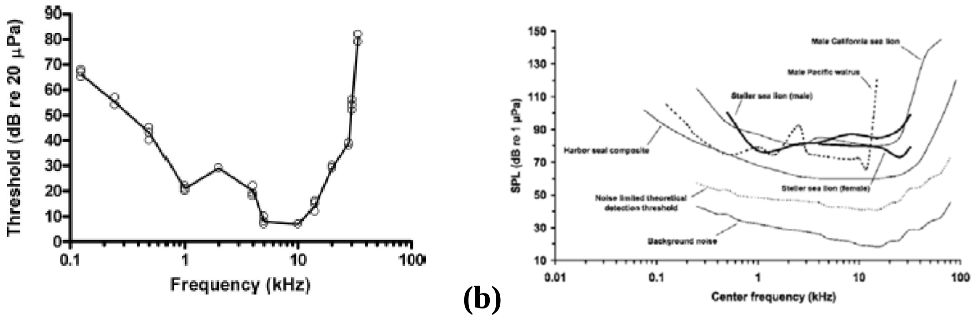
Gentry (1970) and Sandegren (1970) described a suite of sounds that Steller sea lions form while on their rookeries and haulouts. These sounds include threat displays, vocal exchanges between mothers and pups, and a series of roars and hisses. Poulter and DelCarlo (1971) reported that Steller sea lions produce clicks, growls, and bleats underwater.

On land, territorial male Steller sea lions usually produce low frequency roars (Loughlin et al. 1987). The calls of females range from 30 Hz to 3 kHz, with peak frequencies from 150 Hz to 1 kHz for 1.0 to 1.5 seconds.

Kastelein et al. (2005) also described the underwater vocalizations of Steller sea lions, which include belches, barks, and clicks. The underwater audiogram of the male Steller sea lion in their study had a maximum hearing sensitivity at 77 dB RL at 1kHz. His range of best hearing, at 10dB from the maximum sensitivity, was between 1 and16 kHz. His average pre-stimulus responses occurred at low frequency signals. The female Steller sea lion's maximum hearing sensitivity, at 73 dB received level, occurred at 25 kHz. These authors concluded that low frequency sounds are audible to Steller sea lions. However, because of the small number of animals tested, the findings could not be attributed to individual differences in sensitivity or sexual dimorphism (Kastelein et al. 2005b).

The ability to detect sound and communicate underwater is important for a variety of Steller sea lion life functions, including reproduction and predator avoidance. NMFS categorizes Steller sea lions in the otariid pinniped functional hearing group, with an applied frequency range between

60 Hz and 39 kHz in water (NMFS 2016f) (Figure 15).



(a) (b)

Figure 15. Underwater and aerial (in-air) audiograms for Steller sea lions: (a) Mulsow and Reichmuth (2010b) for juvenile, aerial; (b) Kastelein et al. (2005c) for adult male and female, underwater [audiograms of harbor seal, California sea lion, and walrus for comparison].

4.6.5 Steller Sea Lion Critical Habitat

NMFS designated critical habitat for Steller sea lions on August 27, 1993 (58 FR 45269). In Alaska, designated critical habitat includes the following areas as described at 50 CFR §226.202.

1. Terrestrial zones that extend 3,000 feet (0.9 km) landward from each major haulout and major rookery in Alaska.
2. Air zones that extend 3,000 feet (0.9 km) above the terrestrial zone of each major haulout and major rookery in Alaska.
3. Aquatic zones that extend 3,000 feet (0.9 km) seaward of each major haulout and major rookery in Alaska that is east of 144^{o} W longitude.
4. Aquatic zones that extend 20 nm (37 km) seaward of each major haulout and major rookery in Alaska that is west of 144^{o} W longitude.
5. Three special aquatic foraging areas: the Shelikof Strait area, the Bogoslof area, and the Seguam Pass area, as specified at 50 CFR §226.202(c).

A small portion of Steller sea lion critical habitat is within the Action Area (Figure 16 and Figure 17). This includes 14 total known sites (Table 12), among them one major rookery (Sugarloaf) and 12 major haulouts that are identified by regulation (see Tables 1 and 2 to 50 CFR Part 226) and part of the Shelikof Strait Special Aquatic Foraging Area (see 50 CFR §226.202(c)(1)). This also includes the terrestrial, air, and aquatic zones around each major rookery and the major haulouts that are designated as critical habitat per 50 CFR §226.202(a) and Tables 1 and 2 to 50 CFR Part 226. The action area also includes 20 other known haulouts that are not part of the designated critical habitat.

Western DPS Steller sea lions may be affected by a number of natural and anthropogenic factors present in the action area. Many of these factors also have the potential to affect PBFs of this species' designated critical habitat. Natural threats to critical habitat include environmental variability, catastrophic events, competition with predators for prey resources, and exposure to naturally occurring toxins (e.g., HABs). Anthropogenic risk factors include: 1) reductions in prey due to competition with fisheries, and 2) habitat loss or degradation resulting from exposure to toxic substances, the presence of anthropogenic noise, continued coastal development, and the presence of vessel traffic and tourism. These threats may occur individually or collectively (NMFS 2008a; NMFS 2010b; NMFS 2015), and may affect essential physical and biological features of their designated critical habitats that are essential to their conservation. Threats to Steller sea lion critical habitat are discussed in section 4.10.

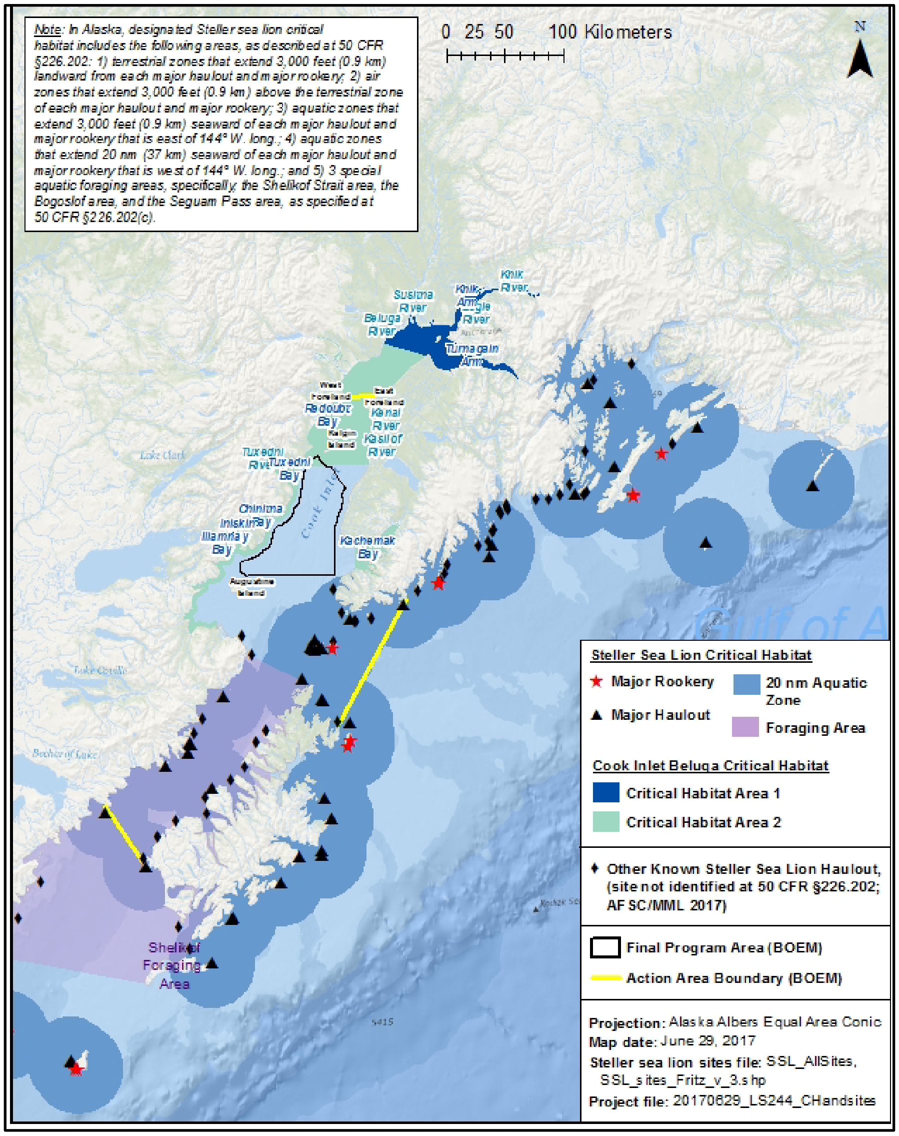


Figure 16. Steller Sea Lion Haul Out, Rookery Sites, and Critical Habitats. Figure by NMFS, Anchorage Field Office, 2017.

Prey resources are the most essential feature of marine critical habitat for Steller sea lions (NMFS 2010b). The status of critical habitat is best described as the status and availability of the important prey resources contained within those areas, which include pollock, Atka mackerel, salmon, Pacific cod, arrowtooth flounder, Irish lord, rock sole, snailfish, herring, capelin, sand lance, other forage fish, squid, and octopus. Dominant prey items vary with region and season, but the most significant groundfish prey items for Steller sea lions in the western DPS are Atka mackerel, pollock, Pacific cod, and arrowtooth flounder, each of which have at least a 10 percent frequency of occurrence in the Steller sea lion diet (NMFS 2010b).

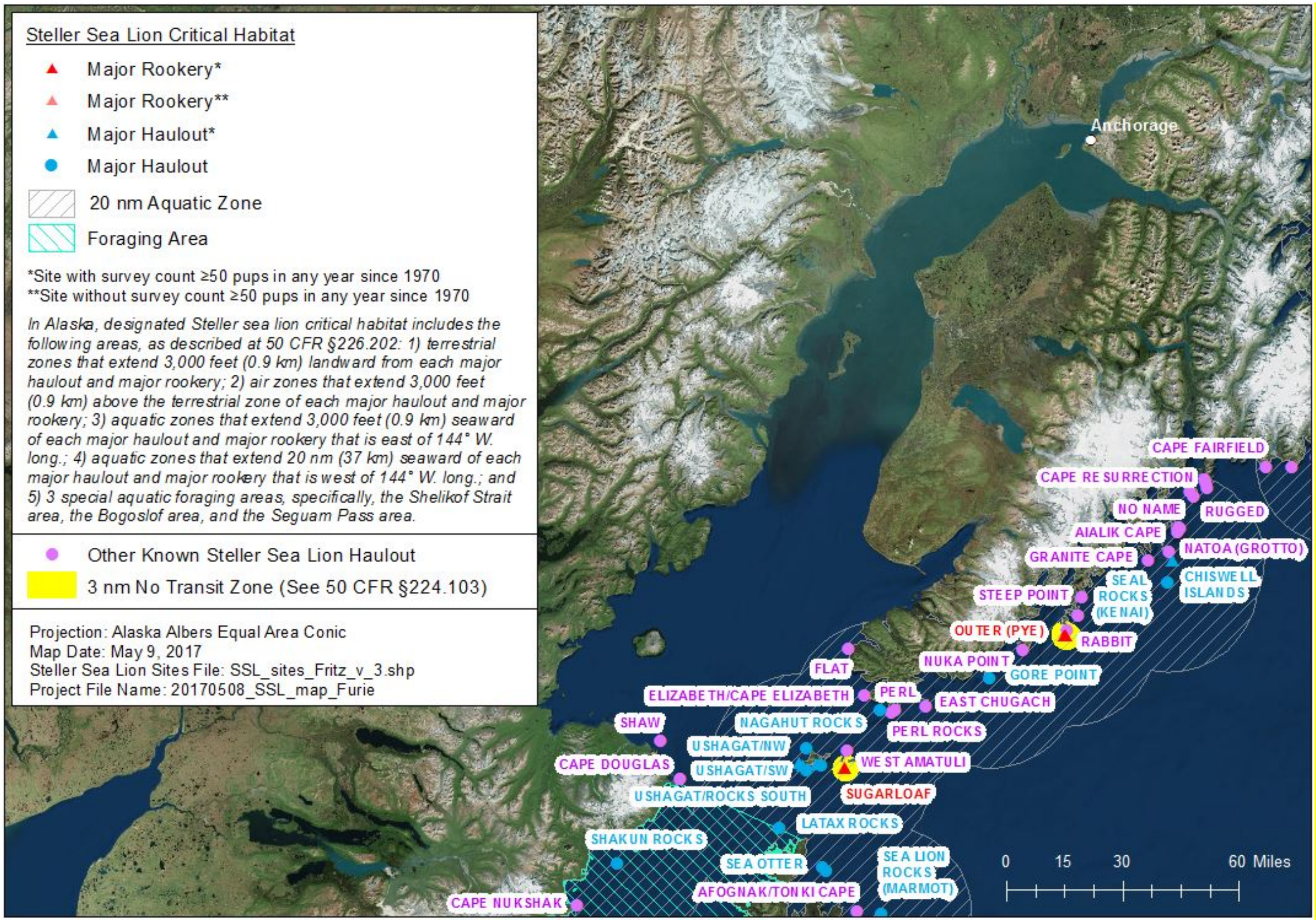


Figure 17. Steller sea lion haulouts, rookeries, and critical habitat boundaries near Cook Inlet, Alaska.

5 ENVIRONMENTAL BASELINE

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

This section focuses on existing natural and anthropogenic activities within the action area and their influences on Cook Inlet beluga whales, Cook Inlet beluga whale critical habitat, fin whale, Western DPS humpback whale, Mexico DPS humpback whale, western DPS Steller sea lion, and Steller sea lion critical habitat.

Cook Inlet beluga whales may be impacted by a number of anthropogenic activities present in upper and mid-Cook Inlet (Table 13). The Cook Inlet Beluga Whale Recovery Plan (NMFS 2016d), evaluated environmental baseline threats to the species, with indicators regarding degree of past mortality caused by each stressor, likelihood of each stressor to have adverse effects on the species, and the significance of each threat to the species (Table 13). These same stressors will affect other species discussed in this consultation to varying degrees.

Table 13. Synopsis of environmental baseline threats to Cook Inlet beluga whales that are entirely or partially anthropogenic in nature (NMFS 2016d).

Threat Type	Past Mortality?	Likely to adversely affect?	Significance of threat to population[1]
Coastal development	None known	Yes	Medium
Marine-based oil and gas development	None known	Yes	Low
Transmission lines	None known	Unknown	Low
Oil and Gas industrial noise	None known	Unknown	Low
Vessel noise	None known	Unknown	Low
Seismic exploration noise	None known	Yes	High
Aircraft noise	None known	Unknown	Low
Coastal development noise	None known	Unknown	Medium
Water quality	None known	Unknown	Low
Contaminants	None known	Unknown	Low
Stormwater runoff	None known	Unknown	Unknown
Aircraft de-icing	None known	Unknown	Unknown
Ballast water	None known	Unknown	High
Point-source releases	None known	Yes	High
Fishery interactions	None known	Unknown	Medium/High
Incidental take in fisheries	None known	No	Low
Poaching or illegal harassment	None known	Unknown	Medium
Subsistence harvest	High	Yes	Low
Ship strikes	Suspected	Yes	Medium
Research	Low	Yes	Low

[1] Represents level of relative concern expressed in Final Cook Inlet Beluga Recovery Plan (NMFS 2016d).

Existing Stressors within the Action Area

The following discussion summarizes the principal anthropogenic stressors that affect endangered and threatened species and designated critical habitat within the action area:

- Coastal Development
- Oil and Gas Development
- Underwater Transmission Lines (and other underwater installations)
- Anthropogenic Noise
- Water Quality
- Fisheries Interactions
- Direct Mortalities
- Research
- Climate Change
- Natural Catastrophic Changes

Other potential stressors were considered, but, alone or in combination with the principal stressors addressed in this Section, are likely to cause only an undetectable to minimal impact on endangered and threatened species and designated critical habitat within the action area.

5.1 Coastal Development

Southcentral Alaska is the State's most populated and industrialized area. Many cities, villages, ports, airports, treatment plants, oil and gas platforms and refineries, highways, and railroads are situated adjacent to, and in some cases in, Cook Inlet. Beluga whales and western DPS Steller sea lions use nearshore environments to rest, feed, and breed and thus could be affected by any coastal development that impacts these activities. Some development has resulted in both the loss and alteration of nearshore habitat and changes in habitat quality due to vessel traffic, noise, and pollution. There is concern that increased development may prevent beluga whales and western DPS Steller sea lions from reaching important feeding and breeding areas. Frequent use of shallow, nearshore, and estuarine habitats makes beluga whales and western DPS Steller sea lions particularly prone to regular interaction with human activities (Perrin 1999), and thus the animals are likely to be affected by those activities.

Construction noise in Cook Inlet is associated with activities such as dredging and pile driving. The majority of construction activities have taken place near Anchorage, north of the action area; therefore, most of the studies documenting coastal development-related construction noise in Cook Inlet have occurred outside of the action area. Additionally, these studies have focused on pile driving activities because of the major concerns of potential harassment to beluga whales from in-water noise produced by this activity. As a result there is very little to no documentation of noise levels from other coastal construction activity in Cook Inlet. Only one study recorded dredging noise near the Port of Anchorage (POA) (SFS 2009).

Noise levels from construction activities are presented in Table 14. Small and/or private docks also may utilize pile driving as a part of their expansions or repairs, e.g., the OSK dock in Nikiski was approved to be upgraded and expanded in 2012. Repair of sewage lines and construction of dock facilities occurred during that project, introducing noise to the marine environment.

Table 14. Summary of construction activity noise levels found in Cook Inlet (NMFS 2016a).

Study	Pile	Vibratory	Impact	Dredge
Blackwell (2005)	91cm diameter	162 and 164 dB re 1 μPa at 56 m[1]	190 and 189 dB re 1 μPa at 62 m[1]	-
URS (2007)	35 cm diameter	120-168 dB re 1 μPa at 600 and 10 m respectively	160-177 dB re 1 μPa at 300-19 m respectively	-
SFS (2009)	76 cm diameter	144 dB_{rms} at 35 m	-	156.9 dB re 1 μPa at 30m
SFS (2009)	sheet	141 dB_{rms} at 757 m	167 dBrms re 1 μPa at 301 m	-
Širović and Kendall (2009)	unknown	183.2 ± 4.8[2] dB re 1μPa at 1 m	196.9 ± 6.1[2] dB re 1 μPa at 1 m	-
[1]Depths of the hydrophone ranged from 1.5-10 m respectively [2]Standard deviation				

Anthropogenic activities related to coastal development may detrimentally affect Cook Inlet beluga and Steller sea lion critical habitat through loss or degradation of habitat and alterations in the availability of prey in critical habitat areas. Anthropogenic activities in the vicinity of Cook Inlet beluga and Steller sea lion critical habitat broadly include dredging; oil or gas activities; hard rock quarrying; laying of electrical, communication, or fluid lines; construction of docks, bridges, breakwaters or other structures; and other activities. These activities may cause avoidance or destruction of an area used by prey as a result of anthropogenic disturbance. Permanent structures, such as docks, platforms, or bridges, can alter the habitat by altering local tidal flow. However, because anthropogenic structures may repel some species, but attract others, the net effect on prey species remains unknown (NMFS, 2010b; NMFS, 2015a).

Cities, villages, ports, airports, wastewater treatment plants, refineries, highways, and railroads are situated on or very near to areas designated as Cook Inlet Beluga Whale critical habitat. This development has resulted in the alteration of near shore beluga habitat and changes in habitat quality due to vessel traffic, noise, and pollution (NMFS, 2011a). Steller sea lion critical habitat has less spatial overlap with areas of current and projected future coastal development, and designated sea lion no-entry zones within critical habitat (see 50 CFR §224.103) help limit the amount of disturbance from vessels, aircraft, and human presence at these important sites. Steller sea lion critical habitat could be affected by coastal development in the manners described for beluga critical habitat.

5.1.1 Road Construction

Alaska Department of Transportation undertook Seward Highway improvements from Mile 75 to 107 (along Turnagain Arm north of the action area) beginning in 2015. These activities include geophysical and geotechnical testing, on-shore blasting, pile removal and installation at stream crossings, and fill placed into Turnagain Arm to facilitate roadway straightening. It also included construction of a restricted-access boat ramp at Windy Point for emergency response, but which will also serve as an easy-access point for non-motorized water sports such as wind surfing and kite surfing.

During marine mammal monitoring efforts, Beluga whales were observed on 15 of the 16 days of monitoring at Twentymile Bridge (6 April–23 April). Beluga whales were also observed twice on two separate days during both high tides at the Twentymile River. Even though no in-water activities occurred at night (at Twentymile Bridge), roadway flaggers present throughout the night mentioned they could hear beluga whales breathing during nighttime hours. Beluga whales were initially observed from the Twentymile River observation location a maximum of 2 hours and 9 minutes prior to the estimated high tide at Twentymile River. During the 2015 season, there were 18 observations of beluga whale groups, with each group size ranging from 3 to 30 animals. On thirteen occasions, in-water work was shut down due to the presence of beluga whales. On three additional occasions, work was already shutdown for other stop-work occurrences, including changes in drilling holes, shifts ending, equipment breakdown delays, weather conditions, or other reasons when beluga whales were initially sighted. Shutdowns typically occurred when beluga whales were at the mouth of Twentymile River to ensure the animals did not enter the harassment zone during in-water activities (HDR 2015). No takes of listed species were reported to have occurred during project activities, although project operations were shut down over a dozen times.

5.1.2 Port Facilities

Port facilities in Cook Inlet are found at Anchorage, Port Mackenzie, Tyonek, Drift River, Nikiski, Kenai, Anchor Point, and Homer.

<u>Port of Anchorage</u>

The Port of Anchorage (POA) is Alaska's largest seaport, located in upper Cook Inlet, at the entrance to Knik Arm, which is north of the action area. The POA provides 90 percent of the consumer goods for about 85 percent of Alaska. It includes three cargo terminals, two petroleum terminals, one dry barge berth, two railway spurs, and a small craft floating dock, plus 220 acres of land facility. About 450 ships or tug/barges call at the POA each year. Operations began at the POA in 1961 with a single berth. Since then, the POA has expanded to a terminal with five berths that moves more than four million tons of material across its docks each year (POA et al. 2009). The Port of Anchorage is in the process of expanding. During the POA sheet pile driving activities between 2009 and 2011, 40 beluga whales were observed within the designated 160 dB harassment zones, ranging from a high of 23 in 2009 to a low of 4 in 2011. A single Steller sea lion was sighted at the facility in 2009, and take of this animal was reportedly avoided by shutting down the pile driving activity. During 2016, the POA conducted a test-pile program to evaluate sound attenuation devices for potential use on the many piles they plan to drive during future port expansion efforts. During the course of this project, belugas entered the level B exclusion zone on 9 occasions, with 7 of those occurrences taking place on a single day (May 25th, 2016). Only one 4-minute delay of start of operations was necessitated to avoid prohibited takes of belugas, and one authorized instance of level B harassment occurred, affecting a single whale (Cornick and Seagars 2016). Phase one of the expansion (upgrades to the petroleum and cement terminals) is expected to begin in 2018, as is shoreline stabilization in the northern port area.

Maintenance dredging at POA began in 1965, and is an ongoing activity from May through November in most years, affecting about 100 acres of substrate per year. Dredging at the POA does not seem to be a source of re-suspended contaminants (USACE 2005, 2008), and belugas often pass near the dredge, apparently undisturbed by its perennial presence.

Castellote et al. (2016b) reports the following regarding potential acoustic impacts of anthropogenic activities near the Port of Anchorage.

> Weekly mean of daily beluga Dives per hour from Cairn Point, Point MacKenzie, and Six Mile are surprisingly low compared to the Dives per hour obtained in the upper part of Knik Arm. Kendall et al. (2013) suggested that belugas might be displaced from the east side of the lower Knik arm due to construction activities at the Port of Anchorage, or that belugas might reduce their vocal activity when transiting through this area, or that beluga acoustic signals might be masked by anthropogenic noise. There is evidence of a decrease or even a cessation of acoustic activity of belugas in the presence of natural predators (i.e., killer whales) or engine noise disturbance. This acoustic response has been observed in both captive and free-ranging belugas and has been interpreted as a survival strategy to avoid detection by predators (Morgan 1979, Lesage et al. 1999, Castellote and Fossa 2006). Therefore, a reduction in acoustic detections could be plausible in areas of high anthropogenic noise, such as the lower Knik Arm.

Port MacKenzie

Port MacKenzie is along western lower Knik Arm, in upper Cook Inlet, across from Anchorage, which is well north of the action area. Development on the port began in 2000 with the construction of a barge dock. Additional construction has occurred since then, and Port MacKenzie currently consists of a 152 m (500 ft.) bulkhead barge dock, a 366 m (1,200 ft.) deep draft dock with a conveyor system, a landing ramp, and more than 8,000 acres of adjacent uplands. Current operations at Port MacKenzie include dry bulk cargo movement and storage. The seawall to this port has failed twice (in the winter of 2015-2016 and 2016-2017), necessitating emergency pile driving and other repair measures to avoid additional loss of fill and damage to sheet piles. Emergency ESA section 7 consultations occurred after much of the repair work had been completed. However, during April 2016, marine mammal monitoring occurred on site during pile driving operations. Observers recorded belugas in or near the pile driving exclusion zone on 12 occasions on 7 days from April 18-26. However, no pile driving was actively occurring during any of these close approaches, so no takes occurred and no shut-downs were ordered (Pers. Comm. Scott Nygard, Tutka LLC May 4, 2016).

Other Ports

The Drift River facility in Redoubt Bay (just beyond the northwest corner of the Lease Sale 244 area and within the action area) is used primarily as a loading platform for shipments of crude oil. The docking facility there is connected to a shore-side tank farm and designed to accommodate tankers in the 150,000 deadweight-ton class. In 2009, a volcanic eruption of Mt. Redoubt forced the evacuation of the terminal and an eventual draw-down of oil stored on-site. Hilcorp Alaska bought the facility in 2012 and, after numerous improvements, partially reopened the facility to oil storage and tanker loading operations.

Nikiski is home to several privately owned docks. Activity at Nikiski includes the shipping and receiving of anhydrous ammonia, dry bulk urea, liquefied natural gas, sulfuric acid, petroleum products, caustic soda, and crude oil. In 2014, the Arctic Slope Regional Corporation expanded and updated its dock in Nikiski, referred to as the Rig Tenders Dock, in anticipation of increased oil and gas activity in Cook Inlet and to serve activities in the Chukchi and Beaufort seas.

Ladd Landing beach, located on the Western Cook Inlet beach near Tyonek, serves as public access to the Three Mile Subdivision, and as a staging area for various commercial fishing sites in the area. While it is outside of the action area, it is one of the few watercraft access points on Cook Inlet's western shore.

Western DPS Steller sea lions are affected by activities at ports throughout their range, especially where fish processing and noise overlap, such as in Kodiak harbor. Within the action area, port activities in Homer, Port Graham, and Nikiski are most likely to affect western DPS Steller sea lions.

The proposed action will possibly include port activities in Nikiski, Kenai, and/or Homer, from which vessel and air transits to the LS 244 leasing blocks may occur; these ports are included in the action area. Kodiak harbor is not in the action area.

5.2 Oil and Gas Development

Cook Inlet provides natural gas to the State's largest population centers. Platforms, pipelines, and tankers represent potential sources of spills. Due to their infrequent occurrence in Cook Inlet, fin whales, humpback whales, and western DPS Steller sea lions likely experience insignificant impacts from the existing marine oil and gas development in this area.

Lease sales for oil and gas development in Cook Inlet began in 1959 (ADNR 2015). Prior to the lease sales, there were attempts at oil exploration along the west side of Cook Inlet. By the late 1960s, 14 offshore oil production facilities were installed in upper Cook Inlet, indicating that most of the Cook Inlet platforms and much of the associated infrastructure is over 40 years old.

Today, there are a total of 17 platforms in Cook Inlet (ADNR 2017) and 252 active oil and gas leases, totaling approximately 558,307 acres of leased State land of which 247,425 acres are on land and 310,881 acres are in Cook Inlet (http://dog.dnr.alaska.gov/documents/leasing/periodicreports/lease_lasactiveleaseinventory.pdf accessed 9/01/17). ADNR plans to conduct annual Cook Inlet area wide oil and gas lease sales during the next five years.

Significant oil and gas development in Cook Inlet takes place within the action area (Figure 18). Stanley et al. (2011) provide USGS point estimates for undiscovered volumes of hydrocarbons in Cook Inlet as follows:

- 19.04 trillion cubic feet of natural gas
- 599 million barrels of oil
- 46 million barrels of natural gas liquids

Schenk and Nelson (2015) determined that there may also be unconventional oil and gas accumulations in Cook Inlet of up to 637 billion cubic feet of gas and 9 million barrels of natural gas liquids. Unconventional oil and gas accumulations: (1) have Estimated Ultimate Recoveries (EUR) generally lower than conventional wells, (2) have low permeability and porosity, (3) require artificial stimulation for primary production, most commonly by hydraulic fracturing. (4) have only local to no migration of hydrocarbons (source rocks are reservoirs or in close proximity to reservoirs), (5) have no well-defined trap or seal, (6) have variable water production, (7) are generally not buoyant upon water, (8) have few truly dry holes, (9) have abnormal pressures, and (10) are regional in extent.

Based on existing active leases and estimates of undeveloped oil and gas resources, oil and gas development will likely continue in Cook Inlet; however, the overall effects on the Cook Inlet beluga whale are unknown (NMFS 2008a). Potential impacts from oil and gas development on the Cook Inlet beluga whale include increased noise from seismic activity, vessel traffic, air traffic, and drilling; discharge of wastewater and drilling muds; habitat loss from the construction of oil and gas facilities; and contaminated food sources and/or injury resulting from an oil spill or natural gas blowout (NMFS 2008a).

5.3 Underwater Installations

There are approximately 365 km (227 mi) of undersea pipelines in Cook Inlet, including 125 km (78 mi) of oil pipelines and 240 km (149 mi) of gas pipelines (ADNR 2015). One additional project has been approved, and one project is currently undergoing ESA section 7 consultation.

Trans-Foreland Pipeline

In 2014, the Trans-Foreland Pipeline Co. LLC (owned by Tesoro Alaska) received approval from state, Federal, and regional agencies to build the Trans-Foreland Pipeline, a 46.7-km (29-mi) long, 20.3-cm (8-in) diameter oil pipeline from the west side of Cook Inlet to the Tesoro refinery at Nikiski and the Nikiski-Kenai Pipeline company tank farm on the east side of Cook Inlet. The pipeline will be used by multiple oil producers in western Cook Inlet, to replace oil transport by tanker from the Drift River Tank farm. Horizontal directional drilling (HDD) will be used at nearshore locations at the East and West Forelands to install the pipeline.

Hilcorp CIPL Extension

Hilcorp plans to extend their existing undersea pipeline network to connect their Tyonek platform to the land-based Tyonek/Beluga, Alaska, pipeline at a point about 4 miles (6.4 km) north of the village of Tyonek. Hilcorp has applied for the following levels of MMPA Level B take for their CIPL extension pipeline project: 23 Cook Inlet beluga whales, 117 harbor seals, 2 harbor porpoises, 3 Steller sea lions, 1 humpback whale, and 1 killer whale.

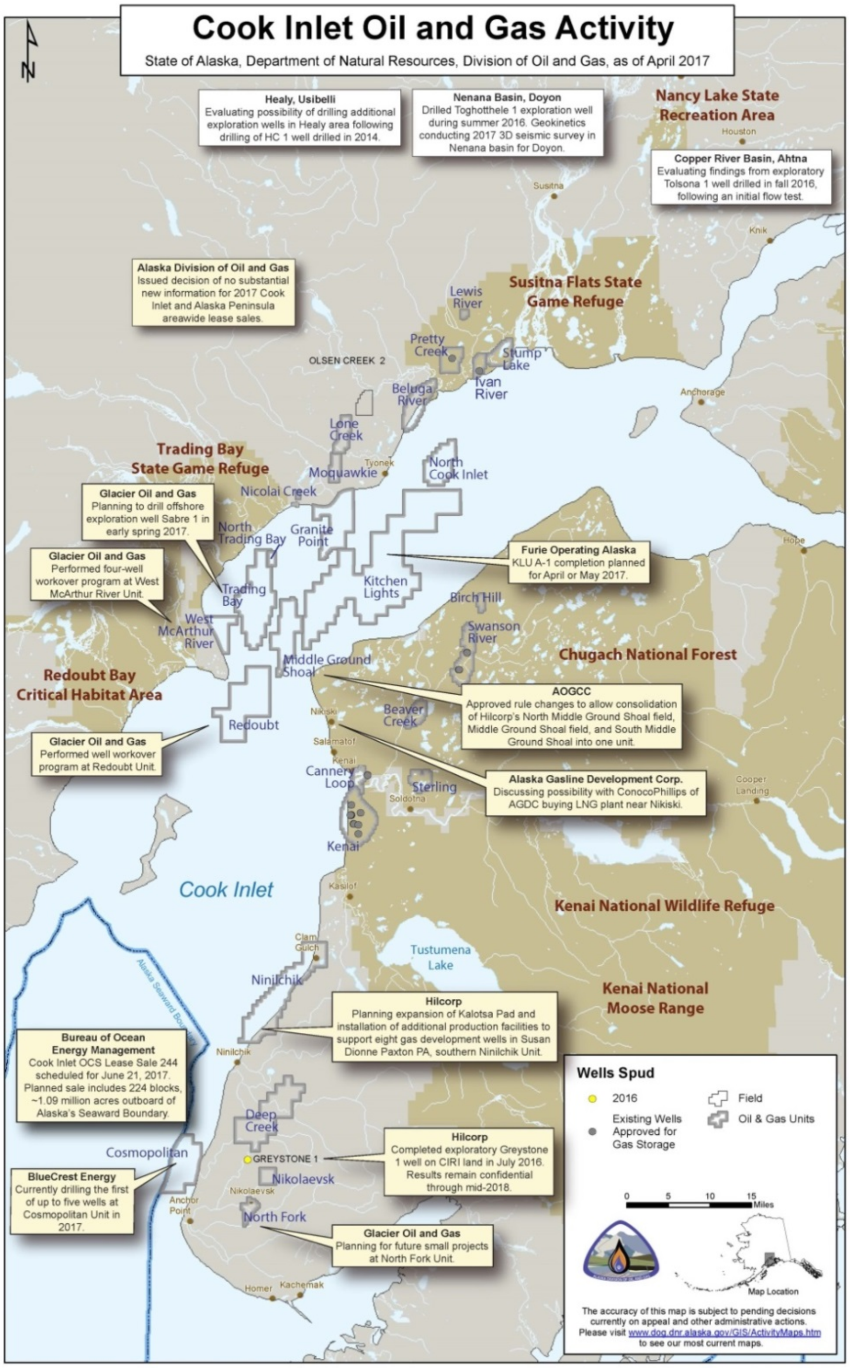


Figure 18. Oil and Gas operations in the Cook Inlet region. From: http://dog.dnr.alaska.gov/gis/data/activitymaps/cookinlet/cookinletoilandgasactivitymap-201612.pdf

5.4 Natural and Anthropogenic Noise

Underwater sound levels in Cook Inlet arise from many sources, including physical noise, biological noise, and human-caused noise. Physical noise includes wind, waves at the surface, currents, earthquakes, ice movement, and atmospheric noise (Richardson et al. 1995). Biological noise includes sounds produced by marine mammals, fish, and invertebrates. Human-caused noise consists of vessel motor sounds, oil and gas operations, maintenance dredging, aircraft overflights, and construction noise.

5.4.1 Ambient Noise Levels

Ambient sound varies within Cook Inlet. In general, ambient and background noise levels within the action area are assumed to be less than 120 dB whenever conditions are calm, and exceeding 120 dB during storm events (Blackwell and Greene 2003; Illingworth and Rodkin 2014).

Much of upper Cook Inlet is a poor acoustic propagation environment due to shallow depths and sand and mud bottoms. Ambient noise levels are highly variable due to high background noise from currents, glacial sediments (Blackwell and Greene Jr. 2002), anthropogenic noise, and ice. The Anderson et al. (2007) studies revealed very high ambient (background) noise levels within the area – as high as 160 dB, which is inconsistent with most other findings. Blackwell and Greene Jr. (2002), recorded low-frequency (less than 200 Hz) ambient noise at much lower levels – around 120 dB. Castellote et al. (2016b) analyzed five years of acoustic data (July 2008 to May 2013) that were collected as part of the thirteen mooring Cook Inlet Beluga Acoustics (CIBA) program, and found no ambient noise level above 140 dB. Using a subset of the CIBA dataset, Castellote et al. (2016b) discerned five different anthropogenic noise classes at the Eagle River mooring from data collected in August 2010 and September 2010. These classes are summarized in Table 15 below. Multiple studies indicate measured background levels in the upper Cook Inlet and Knik Arm, near Anchorage and the Joint Base Elmendorf Richardson (JBER) are rarely below 125 dB re 1 μPa, except in conditions of no wind and slack tide (Blackwell and Greene Jr. 2002, Blackwell 2005, URS 2007, Scientific Fishery Systems 2009). JBER conducted a pilot noise study in October 2012, and documented underwater background noise levels in Knik Arm that ranged between 118-130 dB_{rms} re 1μPa, with a mean of 125 dB_{rms} re 1μPa, while acoustic studies conducted in 2010 documented background sound levels between 110.78 dB_{rms} re 1μPa in September and 129 dB_{rms} re 1μPa in July (HDR Alaska 2011).

The apparent disparity in ambient noise levels between the Anderson et al. (2007) study and the others could be due to differences in environmental conditions, equipment, instrument calibration, or post processor calculations of the noise energy.

5.4.2 Oil and Gas Exploration and Production Noise

Increased noise from seismic activity, vessel and air traffic and well drilling could result from oil and gas development. Oil produced on the western side of Cook Inlet is transported by tankers to the refineries on the east side. Refined petroleum products are then shipped to other parts of Alaska. Liquid gas is also transported via tankers once it is processed (ADNR 2009). Offshore drilling is generally conducted from drilling vessels or platforms.

Seismic Exploration

Cook Inlet has a long history of oil and gas activities including seismic exploration, G&G surveys, exploratory drilling, increased vessel and air traffic, and platform production operation. A seismic program occurred near Anchor Point, Alaska, in the fall of 2005. Geophysical seismic operations were conducted in Cook Inlet during 2007, near Tyonek, East and West Forelands, Anchor Point, and Clam Gulch. Additional small seismic surveys were conducted in Cook Inlet during 2012. A large seismic program took place in 2013 and 2014; data were collected between Anchorage and Anchor Point. Another large seismic survey took place in 2015 and 2016 in Cook Inlet between Beluga, Alaska, and across Cook Inlet to Salamatof, Alaska, and along the eastern inlet between Kalifornsky, Alaska, and south to Anchor Point. ADNR (2015) notes that since December 31, 2013 approximately 3,367 km2 (1,300 mi2) of 3D and 40,000 km (25,000 mi) of 2D seismic line surveys have been conducted in Cook Inlet.

Seismic surveys use high energy, low frequency sound in short pulse durations to characterize subsurface geology (Richardson et al. 2013). Geophysical seismic activity has been described as one of the loudest human-made underwater noise sources, with the potential to harass or harm marine mammals, including listed species in the action area.

Smaller arrays (440-2,400 in^3) are typically used in Cook Inlet because of the generally shallow water environment and the increased use of ocean-bottom cable and ocean-bottom node technology.

Recent seismic surveys in Cook Inlet have used maximum airgun arrays of 1,760 and 2,400 in^3 with source levels of about 237 dB re 1 μPa_{RMS}. Shallow water surveys have involved 440, 620, and 880 in^3 arrays with source sound pressure levels less than 230 dB re 1 μPa_{RMS}. Measured radii to Level B (160 dB) harassment isopleths have ranged from 3 to 9.5 km (1.8-5.9 mi).

Blackwell and Greene Jr. (2002) recorded underwater noise produced at *Phillips A* oil platform at six locations at distances ranging from 0.3-19 km. The highest recorded sound level was 119 dB at a distance of 1.2 km (0.75 mi) (Table 15). The noise from the platform was operating, not drilling noise, and was generally below 10 kHz. In general, noise from the platform itself is thought to be very weak because of the small surface area (the four legs) in contact with the water (Richardson et al. 2013) and that the majority of the machinery is on the deck of the platform, which is above the water surface. However, noise carried down the legs of the platform likely contributed to the higher noise levels than anticipated (Blackwell and Greene Jr. 2002). Noise between two and 10 kHz was measured as high as 85 dB as far out as 19 kilometers from the source. This noise is audible to beluga, humpback, and fin whales and Steller sea lions.

Table 15. Received levels and frequencies of some noise sources in Cook Inlet (NMFS 2016a).

Source	Received Level (dB re 1 µPa)	Distance	Frequency (kHz)
Ambient Noise[1]			
Knik Arm (Outside the Action Area)			
Birchwood	95	-	-

		Mouth of Eagle River	118	-	-
		Joint Base Elmendorf-Richardson	119	-	-
		Port of Anchorage	113	-	-
		Anchorage International Airport	105	-	-
	Upper Cook Inlet (Outside the Action Area)				
		Mouth of Little Susitna River	100	-	-
		Between Fire Island and the Mouth of Susitna River	113	-	-
		North of Point Possession	120	-	-
Vessel Noise[1]					
	Cargo Freight – Northern Lights (docked)		126	100-400 m	Generally <1 kHz
	Cargo Bulk Carrier – Emerald Bulker (with two tugs)		134	>200 m	
	Tug – Leo (pushing gravel barge Katie II)		149	100 m	
	Small Boat – Boston Whaler (drive by)		138	13 m	
	Small Rigid Hull Inflatable (drive by)		142	8.5 m	
Aircraft Noise[1]					
	Joint Base Elmendorf-Richardson		128.0 $\pm$ 9.0	-	Generally <2 kHz
		DC-10	124[3]	-	
		Landing Military Jet	134	-	
	Anchorage International Airport		118.4 $\pm$ 5.7[2]	-	
Oil and Gas Drilling Noise[1]					
	Philip A Oil Platform		119[3]	1.2 km	<10 kHz
[1]Blackwell and Greene (2003) [2]Mean and standard deviation [3]Maximum values					

AK LNG (2016)

In 2016, ExxonMobil Alaska LNG LCC (EMALL) conducted geophysical and geotechnical surveys in Upper Cook Inlet, including within the Susitna Delta Exclusion Zone (SUDEX), under the terms of an IHA and biological opinion issued by NMFS. Operations involving G&G equipment did not occur within the SUDEX between 15 April and 15 October, 2016. PSOs monitored for all marine mammals prior to and during all vessel movements when vessels were under power within the SUDEX. A total of 3 marine mammal sightings consisting of 5 estimated individuals were seen within the SUDEX. These included 2 sightings of beluga whales (4 individuals), and 1 sighting of a single harbor seal. The two beluga whale sightings occurred, both >700 m from the vessel, thus no beluga whales were observed within 100 m of vessels or likely to approach within 100 m of vessels, which represented the applicable harassment zone for that project. All marine mammal sightings in the SUDEX occurred during non-operational periods (i.e. when no vibracore operations were occurring) (Smultea Environmental Sciences 2016).

Apache Seismic Exploration (2012-2014)

During over 1,800 hours of seismic activity in 2012, Apache Alaska Corporation (Apache) reported zero takes of either beluga whales or Steller sea lions; although some protected marine mammals were observed within zones ensonified to greater than 120 and 160 dB prior to powering down or shutting down of equipment. The company experienced five delays resulting from clearing the 160 dB disturbance zone, six shutdowns, one power-down, one shutdown followed by a power-down, and one speed and course alteration (Lomac-MacNair et al. 2013). In 2014, however, despite implementing a total of 13 shut-downs and 7 ramp-up delays for marine mammals, observers recorded a total of 29 takes (12 beluga whales, 6 harbor porpoise, 9 harbor seals, and 2 humpback whales) from noise exposures (25 at ≥160 dBRMS and 4 at ≥180 dBRMS (Lomac-MacNair et al. 2014). Also during Apache's 2014 operations, about 4 groups of beluga whales occurred less than 500 m from the Apache source vessel during seismic operations (0.0014 groups per hour of effort x 3,029.2 total hours of observation effort) (Lomac-MacNair et al. 2014). The report does not state whether seismic guns were firing at this time. If these close approaches by belugas occurred during operation of the 1,760 in^3 airgun array that was being used, that would represent 4 groups of belugas (of unstated group size) subjected to Level A take (Level A take isopleth for 1,760 in^3 array for cetaceans = 1,840 m). This report mistakenly indicates there were no Level A takes of Cook Inlet beluga whales in that year because mitigation actions were taken immediately upon observation of whales in this zone. However, by the time the whales were observed, unauthorized take had already occurred.

NMFS is aware of at least one humpback whale having been observed and possibly taken in upper Cook Inlet (by harassment and/or injury) by Apache's seismic operations on April 25, 2014, by the M/V Peregrine Falcon operating a 1,760 in^3 airgun array at full volume. The humpback whale was first observed 1.5 km (0.9 mi) from the sound source at a time when all whales within 1.84 km (1.1 mi) of the sound source would have been exposed to MMPA Level A take (sound impulses in excess of 180 dB). Although seismic operations were shut down immediately after observing this animal, the whale apparently was exposed to full volume seismic impulses during the time it transited from 1.84 km to 1.5 km (1.1 mi to 0.9 mi) from the sound source. Assuming seismic shots were fired at 15 second intervals and assuming the whale traveled directly towards the source at the average cruising speed of a humpback whale (4.0 km/hour [2.5 mi/hour]) (Noad and Cato 2007), then this whale would have been exposed to at least 19 shots while it was within the exclusion zone prior to shut-down; 19 shots exceeding the 180 dB threshold for Level A take[11].

SAE 3D Seismic Exploration (2015)

Seismic operations took place in upper Cook Inlet, began on 15 May 2015, and continued until 27 September 2015. Eight vessels operated during the surveys including two seismic source vessels, the M/V Arctic Wolf (AW) and M/V Peregrine Falcon (PF), and one mitigation vessel, the M/V Westward Wind (WW). Seven PSOs were stationed on the source and mitigation vessels, including two on each source vessel (AW and PF), and three on the mitigation vessel (WW). PSOs monitored from the vessels during all daylight seismic operations and most daylight non-seismic operations.

[11] This project occurred prior to the issuance of the new Level A guidance (NMFS 2016f), and references the old 180/190 Level A thresholds.

One trained passive acoustic monitoring (PAM) operator was stationed on a vessel to conduct monitoring during nighttime hours using a dipping or over-the-side (OTS) hydrophone.

A total of 932 sightings (i.e., groups) of approximately 1,878 individual marine mammals were visually observed from 15 May – 27 September 2015. Harbor seals were the most commonly observed species with 823 sightings (~ 1,680 individuals), followed by harbor porpoises with 52 sightings (~65 individuals), sea otters with 29 sightings (~79 individuals), and beluga whales with eight sightings (~33 individuals). Large whale sightings consisted of three humpback whale sightings (~3 individuals), one minke whale (1 individual), and one unidentified large cetacean. Other observations include one killer whale sighting (~2 individuals), one Dall's porpoise, four Steller sea lions, two unidentified dolphins/porpoise, five unidentified pinnipeds, and two unidentified marine mammals.

Passive acoustic monitoring occurred from 1 July – 27 September and yielded a total of 15 marine mammal acoustic detections including two beluga whale and 13 unidentified porpoise. Nine detections occurred during seismic activity and six occurred during non-seismic activity. There were no acoustic detections of baleen whales or pinnipeds.

Of these visual observations and acoustic detections, 207 marine mammals were confirmed within both the Level A (190 and 180 dB) and B (160 dB) exposures zones, resulting in 194 Level B and 13 Level A exposures (Kendall et al. 2015).

Species composition of animals known to occur within the Level B exposure zone, through visual observations, included harbor porpoises, a Steller sea lion, harbor seals, and an unidentified large cetacean. An additional two beluga whales and one unidentified porpoise were acoustically detected within the Level B exposure zone. Marine mammals observed within the Level A exposure zone included harbor porpoises, a Steller sea lion, and harbor seals.

Additional takes were avoided due to the 70 sightings that occurred during clearing the disturbance zone, 14 sightings that occurred during ramp-up, and the 18 shut downs that were implemented because of these sightings. No power downs or speed/course alterations were performed due to marine mammal sightings (Kendall 2015).

Furie Exploration Drilling (2017)

Within the Kitchen Lights Unit (KLU) of Cook Inlet, Furie intends to drill up to nine wells between 2017 and 2021. The KLU is an offshore lease area of 83,394 acres, north of the East Foreland and south of the village of Tyonek in Cook Inlet, Alaska.

The Furie KLU drilling have the potential to affect the endangered Cook Inlet beluga whale, the endangered western North Pacific DPS humpback whale, the threatened Mexico DPS humpback whale, the endangered western DPS Steller sea lion, the endangered fin whale, and designated critical habitat for Cook Inlet beluga whales and Steller sea lions.

Actions associated with this proposed activity include transport of a jack-up rig, the *Randolph Yost* , by up to three tugs to the drilling sites, high-resolution geophysical surveys, pile driving at each drilling location, drilling operations, vessel and air traffic associated with rig operations, fuel storage, and well completion activities.

NMFS completed consultation on this action in 2017 (NMFS 2017). No take is anticipated or authorized for 2017 operations. However, subsequent activities will require MMPA authorization.

5.4.3 Noise and Critical Habitat

Due to the industrial activity, development, and vessel traffic in the vicinity of Cook Inlet beluga and Steller sea lion critical habitat, a wide variety of anthropogenic noise sources are present. Many sources of anthropogenic noise are seasonal and occur during the ice-free months, although anthropogenic noise is present year-round. Sources include vessel noise from tugs, tankers, cargo ships, fishing vessels, small recreational vessels, dredging, pile-driving, military detonations, and seismic surveys (NMFS 2010b; NMFS 2015a).

Steller sea lions frequently haul out on docks and seawalls of busy marinas and boat harbors, areas that see a high level of noise and disturbance, to bask or feed on fish wastes (ADF&G 2016; Cohen 2008; Fry 2006; Hart Crowser 2013). Such behavior suggests they are capable of physically and behaviorally tolerating or habituating to loud and frequent noises, particularly if noise tolerance increases access to concentrations of prey. However, presence of animals in the vicinity of loud noise does not mean that the animal is not stressed by that noise.

Recent literature reviews on the effects of sound on fish (Popper and Hastings, 2009) conclude little is known about these effects and that it is not yet possible to extrapolate from one experiment to other signal parameters of the same noise, to other types of noise, to other effects, or to other species. Limited available scientific literature indicates that noise can evoke a variety of responses from fish. Pile driving can induce a startle response and/or an avoidance response, and can cause injury or death to fish close to the noise source (Abbott and Bing-Sawyer, 2002 in NMFS, 2015a; Halvorsen et al., 2011; NMFS, 2011b). It is likely that fish will avoid sound sources within ranges that may be harmful (McCauley et al., 2003). Recently, McCauley et al. (2017) reported on the impacts of seismic exploration on zooplankton, effects which can be passed on through disruption of a cornerstone of marine food webs. However, it is unknown how seismic effects to local zooplankton populations may affect their availability as food in a system like Cook Inlet, which is subject to extreme tidal action and fairly rapid turnover of water (on the order of a few weeks) due to a net outflow of water resulting from freshwater inputs throughout the basin.

Of all known Cook Inlet beluga and Steller sea lion prey species, only coho salmon (Oncorhynchus kisutch) have been studied for effects of exposure to pile driving noise (Casper et al., 2012; Halvorsen et al., 2012). These studies defined very high noise level exposures (210 dB re 1µPa2.s) as threshold for onset of injury, and supported the hypothesis that one or two mild injuries resulting from pile driving exposure at these or higher levels are unlikely to affect the survival of the exposed animals in a laboratory environment. Illingworth and Rodkin (2009) studied the effects to juvenile coho salmon from pile driving of sheet piles at the Port of Anchorage in Knik Arm of Cook Inlet. The fish were exposed to in-situ noise from vibratory or impact pile driving at distances ranging from less than 1 meter to over 30 meters. The results of this study showed no mortality of any test fish within 48 hours of exposure to the pile driving activities. Subsequent necropsies showed no effects or injuries as a result of the noise exposure.

The effects of noise on other Cook Inlet beluga and Steller sea lion prey species, such as eulachon, gadids, and flounder species, is unknown (NMFS 2016d).

5.5 Vessel Traffic Noise

Cook Inlet is a regional hub of marine transportation throughout the year, and is used by various classes of vessels, including containerships, bulk cargo freighters, tankers, commercial and sport-fishing vessels, and recreational vessels (Figure 19). Vessel traffic is likely to either remain at current levels or increase moderately in the future, as dictated by economic demands (Cape International Inc. 2012).

Vessel traffic includes large shipping, commercial and support vessels, commercial fishing vessels, and personal water craft. Vessel and air traffic are required for support during oil and gas development. Oil produced on the western side of Cook Inlet is transported by tankers to the refineries on the east side. Refined petroleum products are then shipped elsewhere. Liquid natural gas is also transported via tankers once it is processed (ADNR 2015).

Blackwell and Greene (2003) recorded underwater noise produced by both large and small vessels near the POA. The tugboat *Leo* produced the highest broadband levels of 149 dB re: 1 μPa at a distance of approximately 100 m (328 ft), while the docked *Northern Lights* (cargo freight ship) produced the lowest broadband levels of 126 dB re: 1 μPa at 100 to 400 m (328-1,312 ft). Continuous noise from ships generally exceeds 120 dB re 1 μPa_{RMS} to distances between 500 and 2,000 m (1,640 and 6,562 ft), although noise effects are short term as the vessels are continuously moving (BOEM 2017b).

Steller sea lions and humpback and fin whales may exhibit varying reactions to the presence of vessels, ranging from attraction (especially if animals are habituated to vessels as a source of food) to avoidance. Some vessels, such as tugs towing barges or oil rigs, can produce sound capable of harassing marine mammals located over 2 km from the source (Jacobs Engineering 2017). We are unaware of information characterizing the reactions of these species to vessels within the action area or the number of interactions between marine mammals and vessels that cause behavioral changes.

Shipping and transportation in waters may affect Cook Inlet beluga and Steller sea lion habitat through the effects of noise, physical disturbance, and discharge (accidental and illegal) of oil, fuel, or other toxic substances carried by ships. The physical disturbance and noise associated with shipping and transportation activities could displace beluga and sea lion prey species from preferred habitat areas that contain the features essential for those species, or that alter the quantity and/or quality of these essential features for those species (NMFS 2010b; NMFS 2016d). In the event of an oil spill, rookeries, haul-out areas, and shallow water habitats could become oiled, and the quantity and/or quality of these species' primary prey resources could be adversely affected. Vessel traffic and tourism encroachment in critical habitat areas could disturb and displace Cook Inlet belugas, Steller sea lions, and/or their prey species, resulting in reduced conservation value of the critical habitat.

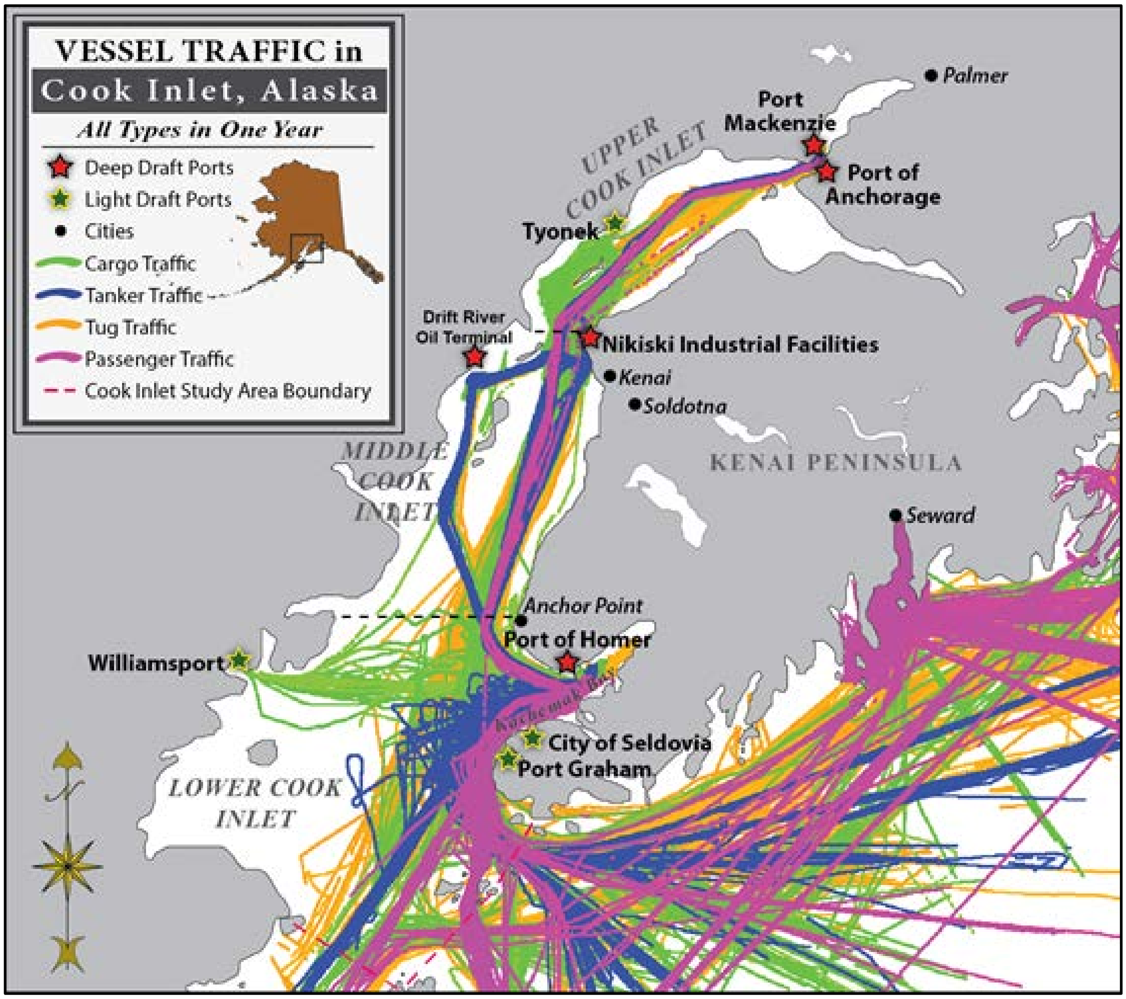


Figure 19. **Summary of Cook Inlet Vessel Traffic by Vessel Type (Cape International, Inc. 2012, BOEM 2017b).**

5.6 Aircraft Noise

Cook Inlet experiences significant levels of aircraft traffic, including private planes, commercial passenger and cargo aircraft, charter aircraft, and government aircraft, including military aircraft. Oil and gas exploration and development projects in Cook Inlet often involve helicopters and fixed-winged aircraft. Aircraft are used for surveys of natural resources, including Cook Inlet beluga whales. Airborne sounds do not transfer well to water because much of the sound is attenuated at the surface or is reflected where angles of incidence are greater than 13°; however, loud aircraft noise can be heard underwater when aircraft are directly overhead and surface conditions are calm (Richardson et al. 1995a).

Richardson (1995) observed that beluga whales in the Beaufort Sea will dive or swim away when low-flying (500 m (1,640 ft)) aircraft passed directly above them. Observers aboard Cook Inlet beluga whale survey aircraft flying at approximately 244 m (800 ft.) observed little or no change in swimming direction of the whales (Rugh et al. 2000). This is likely because beluga whales in Cook Inlet could be habituated to routine small aircraft overflights. Beluga whales may be less sensitive to aircraft noise than vessel noise, but individual responses may be highly variable and depend on previous experiences, beluga activity at the time of the noise, and characteristics of the noise. In addition, ground-based biologists have reported that belugas in this area often sound and remain submersed for longer than is typical when aircraft fly past at low altitudes or circle them overhead (NMFS unpublished data).

Anchorage Airport

The Ted Stevens Anchorage International Airport (ANC) is directly adjacent to lower Knik Arm and has high volumes of commercial passenger and cargo air traffic. It is among the busiest cargo hubs in the United States. Approaches to the airstrips usually have planes taking off and landing over the waters of Cook Inlet or Knik Arm.

Joint Base Elmendorf Richardson

Joint Base Elmendorf Richardson (JBER) has a runway near, and airspace directly over, Knik Arm. Air traffic there includes large surveillance and transport aircraft and fighter jets. Marine mammal monitors have anecdotally reported behavioral responses of Cook Inlet Belugas to low-flying military aircraft in Knik Arm (NMFS, Unpublished data).

Lake Hood

Lake Hood and Spenard Lake in Anchorage comprise the busiest seaplane base in the United States. Charter and private aircraft originating from this base often head across Knik Arm and fly along the coast towards the Susitna Delta. Biologists on site at the Susitna Delta report that some of these aircraft will circle concentrations of beluga whales located within the Susitna Delta, often causing behavioral reactions among the whales (NMFS unpublished data). NMFS is currently undertaking a public education campaign targeting private and charter aircraft pilots to reduce or eliminate these aircraft maneuvers.

Other Airstrips

Other small private and public runways are found in Anchorage, Birchwood, Goose Bay, Merrill Field, Girdwood, near the Susitna Flats area, the Kenai Municipal Airport, Ninilchik, Homer, and Seldovia, some of which are within the action area.

Even though sound is attenuated by the water surface, Blackwell and Greene (2002) found aircraft noise can be loud underwater when jet aircraft are directly overhead. They recorded aircraft noise underwater near ANC and JBER, outside of the action area. Recordings included 15 commercial aircraft and 11 F-15 military jets. Eleven of the 15 commercial aircrafts and two of the 11 military jets were detectable underwater due to sound transmission across air and water.

5.7 Water Quality and Water Pollution

Potential sources of pollutants in Cook Inlet could include: (1) discharge from industrial activities, excluding wastewater treatment facilities; (2) discharge from community wastewater treatment facilities; (3) runoff from urban, agriculture, and mining sources; and (4) accidental spills or discharge from oil and gas production (Moore et al. 2000, NMFS 2008a). Main sources of pollutants found in Cook Inlet likely include the 10 wastewater treatment facilities, stormwater runoff, airport deicing, military training at Eagle Bay, and discharge from oil and gas development (Moore et al. 2000, NMFS 2008a).

Ballast water discharge from ships is another source of potential pollution as well as potential release of non-indigenous organisms into Cook Inlet. Information and statistics ballast water management in Cook Inlet can be found at: https://www.circac.org/wp-content/uploads/2003nov-Cook-Inlet-Ballast-WAter-Catalogue-Nuka.pdf.

Given the amount of oil and gas production and vessel traffic, spills of petroleum products are a source of concern for marine mammals inhabiting Cook Inlet. Research indicates cetaceans are capable of detecting oil, but they do not seem to avoid it (Geraci and St. Aubin 1990a). Oil has been implicated in the deaths of Steller sea lions (St. Aubin 1990).

According to the Alaska Department of Environmental Conservation (ADEC), oil spills database, oil spills to marine waters consist mostly of harbor and vessel spills, and spills from platform and processing facilities. A reported 477,942 L (126,259 gal) (from 79 spills) of oil was discharged in the Cook Inlet area since July 1, 2013, primarily from vessels and harbor activities and from exploration and production facilities. Three of the ten largest spills in Alaska during state fiscal year 2014 occurred in Cook Inlet; these included 84,000 gallons of produced water by Hillcorp in the Kenai gas field; 9100 gallons of process water released by the Tesoro API Tank Bypass Spill; and a Flint Hills, Anchorage spill of 4,273 gallons of gasoline (ADEC 2015).

A spill baseline study conducted by The Glosten Associates and ERC (2012) as part of the Cook Inlet Risk Assessment estimated a historical vessel spill rate of 3.4 spills (regardless of size) per year, with 3.9 spills per year forecasted for the years 2015 through 2020 across all vessel categories. Historical rates ranged from 0.7 spills per year for tank ships to 1.3 spills per year for non-tank/non-workboat vessels (The Glosten Associates and ERC, 2012). Eight large spills (≥ 1000 bbl) from vessels (tankers and, in one case, a tug) are documented in Cook Inlet between 1966 and 2015 (BOEM 2016a). No large spills have occurred in the area in recent years (BOEM 2017b).

Related effects to the marine mammals associated with these events could include death or injury from swimming through oil (skin contact, ingestion of oil, respiratory distress from hydrocarbon vapors), contamination of food sources, or displacement from foraging areas.

Upper Cook Inlet was designated as a Category 3 on the Clean Water Act Section 303(d) list of impaired water bodies by the ADEC (2013), indicating there is insufficient data to determine whether the water quality standards for any designated uses are attained. Lower Cook Inlet is not listed as an impaired waterbody due to lack of information to the contrary; however, the ADEC determined that the overall condition of Southcentral Alaska coastal waters were rated as good based on examining water quality, sediment quality, and fish tissue contaminants collected from 55 sites in the survey area (ADEC 2013).

The Cook Inlet region is the most populated and industrialized region of the state. Its waters receive various pollutant loads through activities that include urban runoff, oil and gas activities (e.g., discharges of drilling muds and cuttings, production waters, treated sewage effluent discharge, deck drainage), municipal sewage treatment effluents, oil and other chemical spills, fish processing, and other regulated discharges. Many pollutants are regulated by either the EPA or the ADEC, who may authorize certain discharges under the National (or Alaska) Pollution Discharge Elimination System (NPDES/APDES; section 402 of the Clean Water Act of 1972 [CWA]). It is necessary to manage pollutants and toxins to protect and maintain the biological, ecological, and aesthetic integrity of these waters.

Cook Inlet beluga whales are exposed to chemical concentrations that are typically lower than those observed in other Arctic marine mammals (Becker et al. 2000, NMFS 2010d). Levels of heavy metals, pesticides, petroleum hydrocarbons, and polychlorinated biphenyl (PCB) compounds found in Cook Inlet's water column and sediments were below detection limits; and heavy metal concentrations were below management levels (KABATA 2004, NMFS 2008a, USACE 2008). ADEC designated upper Cook Inlet as Category 3 on the CWA section 303(d) list of impaired waterbodies (ADEC 2013). A Category 3 designation is the result of insufficient information in determining if the waterbody meets water quality standards. The lower Cook Inlet is not on the list of impaired water bodies (ADEC 2013).

In the action area, waters are generally free of toxins and other agents of a type and amount harmful to the Cook Inlet beluga whales. The only stated source of contamination to Cook Inlet beluga whale critical habitat resulting from the first incremental step is from accidental releases from the marine vessels, drilling muds, effluent from platforms, and unlawful spills from drilled exploration wells. The maximum amount of accidentally-released contamination from vessels is limited to the fuel capacity of the vessels. Spills from wells and pipelines may also occur, but during the development and production stages.

5.7.1 Wastewater Discharge

Ten communities currently discharge treated municipal wastes into Cook Inlet. Wastewaters entering these plants may contain a variety of organic and inorganic pollutants, metals, nutrients, sediments, bacteria and viruses, and other emerging pollutants of concern (EPOCs). Wastewater from the Municipality of Anchorage, Nanwalek, Port Graham, Seldovia, and Tyonek receive primary treatment, wastewaters from Homer, Kenai, and Palmer receive secondary treatment, and wastewaters from Eagle River and Girdwood receive tertiary treatment.

Wastewater treatment facilities undergo primary, secondary, or tertiary treatment prior to being discharged into a body of water. Primary treatment involves sedimentation. In general, this includes removing 30-50 percent of the solid particulate from the wastewater prior to discharge (Viessman and Hammer 1998). In addition to sedimentation, secondary treatment involves adding a biological component to remove the remaining organic matter. Tertiary treatment involves both primary and secondary treatment as well as additional processes to increase the water quality of the discharge (Viessman and Hammer 1998).

The Anchorage John M. Asplund Wastewater Treatment Facility (AWTF) is the largest wastewater facility in Alaska and is located in upper Cook Inlet north of the action area. AWTF provides primary treatment only and removes approximately 80 percent of solids prior to discharge (Anchorage Waste Water Utility [AWWU] 2014). The facility was built in 1972, upgraded in 1982 (28 million gallons per day [mgd]), and then upgraded again in 1989 (58 million mgd). The EPA issues a waiver to AWTF for secondary treatment and allows the direct discharge of wastewater into Cook Inlet near Point Woronzof once the wastewater has undergone primary treatment. AWTF is allowed to discharge primary treated wastewater due to the levels of sediment they are able to extract and the extreme tides and currents of Cook Inlet (AWWU 2014). Once the sediment is removed from the wastewater, the sludge is incinerated.

The Village of Tyonek wastewater treatment facility, also located north of the action area but near the portion of Cook Inlet most heavily used by feeding Cook Inlet beluga whales, provides primary treatment prior to wastewater discharge. Tyonek operates on a gravity fed sewer that drains into a community septic tank. Every spring and fall, the solids are transferred to a sludge lagoon for dewatering. The liquid effluent is then discharged into Cook Inlet. The village uses approximately 60 gallons of water per day, most of which ends up as discharged liquid effluent.

There are other wastewater treatment facilities closer to the action area, including in Kenai. The City of Kenai wastewater facility is one of the larger wastewater treatment facilities in Cook Inlet and is located near the largest runs of salmon in Cook Inlet. The Kenai wastewater treatment facility discharges secondary treated wastewater from its treatment plant directly into Cook Inlet, and the sludge is taken to the Soldotna landfill (EPA 2007). The facility's design flow is 1.330 mgd with an average daily flow of 0.573 mgd (EPA 2007). The City of Kenai is planning to upgrade the facility by 2018 (ADEC 2014).

Wastewater discharge from oil and gas development could increase pollutants in Cook Inlet (NMFS 2008a). Discharge includes but are not limited to drilling fluids (muds and cuttings), produced water (water phase of liquid pumped from oil wells), and domestic and sanitary waste (EPA 2015a). Under the NPDES permit issued by EPA, oil and gas facilities are required to monitor the effluent for pollutants and meet standards specified in the permit before it is discharged into Cook Inlet (EPA 2015a).

5.7.2 Stormwater Runoff

Stormwater pollutants may include street and aircraft deicer, oil, pesticides and fertilizers, heavy metals, and fecal coliform bacteria. WMS and DOT&PF are responsible for identifying, monitoring, and controlling pollutants in stormwater. Stormwater from other communities in the action area (e.g., Kenai) may also contribute to pollutants that enter Cook Inlet. The effects of stormwater on the Cook Inlet beluga whale have not been studied and are unknown (NMFS 2008a).

Numerous releases of petroleum hydrocarbons have been documented from the Port of Anchorage (POA), Joint Base Elmendorf Richard (JBER), and the Alaska Railroad Corporation (ARRC). The POA transfers and stores petroleum oils, as well as other hazardous materials; and since 1992, all significant spills and leaks have been reported. Past spills have been documented at each of the bulk fuel facilities within the POA and also on JBER's property (POA 2003).

JBER is listed on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, because of known or threatened releases of hazardous substances, pollutants, or contaminants. Spills have also been reported at the ARRC rail yard. In 1986, petroleum seeped into Ship Creek from the nearby rail yard, and several oil spills occurred in 2001 (Army 2010). Freight handling activities have historically caused numerous surface stains and spills at the rail yard.

5.7.3 Aircraft De-icing

Airport deicing contributes to the levels of pollutants found in Cook Inlet. Deicing and anti-icing of aircraft and airfield surfaces are required by the Federal Aviation Administration to ensure the safety of passengers. Deicing and anti-icing chemicals are used from October through May and may be used on aircraft, tarmacs, and runways. Depending on the application, deicing material is comprised of different chemicals. Ethylene glycol and propylene glycol are used on aircraft for anti-icing and deicing purposes, whereas potassium acetate and urea are used to deice tarmacs and runways. Much of the deicing material or their breakdown products eventually enter Cook Inlet. No studies exist analyzing the potential impacts on beluga whales from these deicing agents.

The Ted Stevens Anchorage International Airport (ANC) and JBER airport are the largest airports in Cook Inlet. Other smaller airports exist throughout the Cook Inlet watershed, including Merrill Field, Lake Hood, and Lake Spenard (NMFS 2008a).

5.7.4 Ballast Water Discharges

Discharges of wastes from vessels are regulated by the United States Coast Guard. Potential discharges include oily waste, sewer water, gray water (e.g., shower water), ballast water that may contain invasive marine species, and garbage. Gray water and sewer water, provided that they are free from oil waste, may be discharged in the open sea. However, by law, no discharges of any kind are allowed within three miles of land.

Ships can potentially release pollutants and non-indigenous organisms into Cook Inlet through the discharge of ballast water. It is a recognized worldwide problem that aquatic organisms picked up in ship ballast water, transported to foreign lands, and dumped into non-native habitats are responsible for significant ecological and economic perturbations costing billions of dollars. The National Ballast Information Clearinghouse reported that more than five million metric tons of ballast water was released in Cook Inlet, from Homer to Anchorage, between 1999 and 2003. Invasive species were found just off the POA in a 2004 survey by the Smithsonian Environmental Center. The effects of discharged ballast water and possible invasive species from such discharges on fin whales, humpback whales, and Cook Inlet beluga whales and western DPS Steller sea lions and their designated critical habitat are unknown. In order to try to protect Alaska's waters, ADF&G developed an Aquatic Nuisance Species Management Plan (Fay 2002). Information and statistics ballast water management in Cook Inlet can be found at: http://reports.nukaresearch.com/Reports/Cook-Inlet-ballast-water/Draft%201/regulations/

5.7.5 Point Source Contaminant Spills/Releases

Research has shown that while cetaceans are capable of detecting oil they do not seem to avoid it (Geraci 1990). The paucity of data on oiled beluga whales makes it difficult to predict effects of spills on the whales. Oil spills that occur in or upstream of Cook Inlet beluga whale habitat could result in the whales experiencing direct contact with the oil, with possible effects to skin and/or respiratory systems. Cook Inlet beluga whales could be affected through residual oil from a spill, even if they were not present during the oil spill, due to the highly mobile nature of oil in water and the extreme tidal fluctuations in Cook Inlet (NMFS 2008a). Prey contamination is also likely, but the effect of contaminated prey on belugas remains unknown. Spill clean-up efforts could also result in displacement of whales from essential feeding areas.

Polycyclic aromatic hydrocarbons (PAHs), a group of contaminants found in petroleum products, combined with other contaminants, may cause cancer in beluga whales (Kingsley 2002) and are otherwise a concern with respect to the conservation and recovery of the Cook Inlet beluga whale. Cook Inlet belugas appear to be bioaccumulating PAHs from the environment and prey (Norman et al. 2015).

Oil has been implicated in the deaths of Steller sea lions (St. Aubin 1990). Pinnipeds exposed to oil at sea through incidental ingestion, inhalation, or limited surface contact do not appear greatly harmed by the oil; however, pinnipeds found close to the source or who must emerge directly in oil appear substantially more affected.

Toxic substances, such as oil, may be a contributing factor in the decline of the western DPS Steller sea lion population (NMFS 2008d). Sea lions exposed to oil through inhalation, dermal contact and absorption, direct ingestion, or through the ingestion of prey may become heavily contaminated with PAHs. The Exxon Valdez oil spill occurred after the current Steller sea lion population decline began, although this spill almost certainly contributed further to the decline. Mortalities from toxic contamination are strongly linked to this spill. Twelve sea lion carcasses were found in Prince William Sound, and 16 carcasses were found near Prince William Sound, along the Kenai coast, and at the Barren Islands. Elevated PAH levels were present in the animals found dead shortly after the spill (NMFS 2008c).

While construction of an oil/gas facility may result in a small amount of habitat loss, an oil spill in Cook Inlet could result in widespread habitat degradation impacting beluga whales and putting the population at risk. Individuals from the western DPS of Steller sea lions and listed humpback whales within Cook Inlet may also be put at risk due to such a spill, but population level effects would be far less likely, unless the spill was sufficiently large to impact areas outside Cook Inlet.

It is not known whether humpbacks or fin whales avoid oil spills; however, humpbacks have been observed feeding in a small oilspill on Georges Bank (NMFS 1991). The greatest impacts of oil spills on humpbacks (and fin whales) could occur indirectly. Local depletion of food resources may occur as a result of displacement and mortality of their food resources, many of which are highly susceptible to the toxic effects of oil and are essentially unable to move away from the site of a spill. Other more mobile prey species may suffer from mortality of eggs and immature life stages (NMFS 1991), possibly reducing future availability of prey.

As of October 31, 2012, the State of Alaska assumed primacy for Clean Water Act administration and enforcement. From 1984-1994, approximately 10,500 gallons of oil spilled from oil platforms and four gas blowouts have occurred since 1962 (Moore et al. 2000). Offshore oil spill records in Cook Inlet during 1994-2011 (ADNR 2011) show only three spills during oil exploration: two oil spills at the UNOCAL Dillion Platform in June 2011 (two gallons) and December 2001 (three gallons); and one oil spill at the UNOCAL Monopod Platform in January 2002 (one gallon). During the same time, 71 spills occurred offshore during oil production. Most spills ranged from 0.0011-1 gallon (42 spills), while three spills exceeded 200 gallons: 210 gallons in July 2001 (Cook Inlet Energy Stewart facility); 250 gallons in February 1998 (King Salmon Platform); and 504 gallons in October 1999 (UNICOL Dillion Platform). In 2017, ≤ three gallons of natural gas condensate spilled from the Anna platform in Upper Cook Inlet near Granite Point (ADEC 2017), and an unknown quantity of processed dry natural gas was leaked from an 8-inch pipeline between Platform A and Nikiski in Cook Inlet. All 71 crude oil spills from the offshore platforms, both exploration and production, totaled less than 2,140 gallons spread across 17 years. Effects of these spills upon listed species are unknown.

5.7.6 Mixing Zones

In 2010, EPA consulted with NMFS on the approval of the ADEC Mixing Zone Regulation section [18 AAC 70.240], including most recent revisions, of the Alaska Water Quality Standards [18 AAC 70; WQS] relative to the endangered Cook Inlet beluga whale (NMFS 2010d). This biological opinion concluded that there was insufficient information to conclude whether belugas could be harmed by the elevated concentrations of substances present in mixing zones, but that the action was not likely to jeopardize the continued existence of the species. In 2017, EPA initiated formal consultation for this same action and its effects on designated Cook Inlet beluga critical habitat.

5.7.7 Contaminants Found in Listed Species

Studies conducted in upper Cook Inlet, in areas of high concentrations of beluga whales, found levels of polychlorinated biphenyls (PCBs), pesticides, and petroleum hydrocarbons in the water column and sediment were below detectable limits and levels of heavy metals were below management levels (KABATA 2004, NMFS 2008a, USACE 2008).

Becker et al. (2000), compared tissue samples taken from harvested Cook Inlet beluga whales from two Arctic Alaskan populations, Greenland, Arctic Canada, and the St. Lawrence Estuary beluga population. They compared levels of PCBs, chlorinated pesticides, heavy metals, and other elements between populations. The results indicated that the Cook Inlet population had the lowest concentrations of PCBs, pesticides, cadmium, and mercury of all these populations, but had higher concentrations of copper than the other Arctic populations. (Becker et al. 2000) suggested the difference in toxin levels was likely related to a difference in source (geographic or food web) and age distribution of the animals. A follow up study conducted by Becker et al. (2010) did not find significant changes in contaminant levels in the Cook Inlet beluga whale population with the inclusion of additional samples collected over the past decade; however, they did identify and document increasing levels of chemicals of emerging concern (e.g., polybrominated diphenyl ether, hexabromocyclododecane and perfluorinated compounds) in the Cook Inlet population. Although the levels of contaminants found in the Cook Inlet beluga whale population are lower than levels found in other populations, the effects of these contaminants on this population are unknown (Becker et al. 2000, NMFS 2008a) (Becker et al. 2000; NMFS 2008a).

Steller sea lions are exposed to local and system-wide contaminants and pollutants as they traverse the North Pacific basin. Effects on other pinnipeds have included acute mortality, reduced pregnancy rates, immuno-suppression, and reduced survival of first born pups (Section

III), but there have been no published reports of contaminants or pollutants (other than spilled oil) representing a mortality source for Steller sea lions (NMFS 2008b).

5.8 Fisheries Interactions

Fishing is a major industry in Alaska. Within the action area, fishing activities include commercial, subsistence, recreational, and personal use fisheries. Fish harvested include, but are not limited to, all Pacific salmon species, halibut and other groundfish species, and eulachon. Commercial harvest of salmon in Cook Inlet is substantial, averaging 3.5 million fish per year over the past decade (http://www.adfg.alaska.gov/, accessed September 4, 2017). Personal use salmon fisheries in Cook Inlet resulted in harvest of an average of over 465,000 salmon per year over the past decade (http://www.adfg.alaska.gov/index.cfm?adfg=PersonalUsebyAreaSouthcentralKenaiSalmon.harvest). ADF&G reports a historical average subsistence harvest of salmon in Cook Inlet area at under 5,400 fish (http://www.adfg.alaska.gov/techpap/tp406.pdf). Records of non-commercial eulachon harvest rates in Cook Inlet could not be found. Sportfishing accounted for harvest of about 275,000 fish per year over the past 5 years in Cook Inlet saltwater; most of these fish were halibut (http://www.adfg.alaska.gov/, accessed September 4, 2017). Effects of these harvest levels on marine mammals using Cook Inlet, and to Cook Inlet beluga whale or Steller sea lion critical habitat, remains undetermined.

There is no known information summarizing interactions between fishing in Cook Inlet and large cetaceans. Prey competition is unlikely to occur, but some level of disturbance due to fishing vessel noise is likely. We are aware of only two reported vessel strikes of whales in the action area; a humpback whale near Nikiski, and an unknown whale near Homer (Neilson et al. 2012), so the risk of whale dying due to being struck by fishing vessels is minimal, especially so for small recreational watercraft or slow-moving (less than 13 knots) commercial fishing vessels.

Because beluga whales concentrate in upper Cook Inlet during summer (Rugh et al. 2010a), fisheries that occur in those waters during spring and summer could have a higher likelihood of interacting with beluga whales. As a result there may be continued prey competition, risk of ship strikes, potential harassment, potential for entanglement in fishing gear, and potential displacement from important foraging habitat for the Cook Inlet beluga whales.

Subsistence, Personal Use, and Recreational Fisheries

Alaska residents may participate in subsistence and personal use fisheries. Personal use fisheries require a valid Resident Sport Fishing License, whereas subsistence fisheries do not (ADF&G 2017d). Personal Use salmon gillnet fishing occurs near the Kasilof River. Personal use dipnet fisheries for salmon in Cook Inlet occur in the Kenai and Kasilof River area and Fish Creek in upper Cook Inlet. Subsistence fisheries in and near Cook Inlet are open to all Alaska residents, and occur near Tyonek, Seldovia, and Port Graham. Popular recreational fishing streams within the action area include anadromous streams along the west coast of Cook Inlet (NMFS 2008a, ADF&G 2017a). Eulachon harvest locations north of the action area include areas from the Chuitna north to the Susitna and Little Susitna rivers, including the waters of Turnagain Arm

(NMFS 2008a, ADF&G 2017a). Groundfish (e.g., halibut, lingcod, and rockfish) are harvested within the action area. Additionally, littleneck, butter, and razor clams are harvested along Cook Inlet intertidal areas (NMFS 2008a). Potential impacts on the Cook Inlet beluga whale from subsistence, personal use, and recreational fishing include the operation of small watercrafts in the mouths of streams and in shallow waters, harassment, and displacement from important habitat, ship strikes, and prey competition (NMFS 2008a). The overall impacts from subsistence, personal use, and recreational fishing on the recovery of the Cook Inlet population is thought to be low (NMFS 2008a).

Commercial Fisheries

Cook Inlet is comprised of several commercial fisheries, all of which require permits. The commercial fisheries in Cook Inlet are divided into the upper and lower Cook Inlet (ADF&G 2017b, c). Portions of central and southern Cook Inlet district management areas are within the proposed LS244 action area. The upper Cook Inlet commercial fishing region consists of all waters north of Anchor Point Light and is further divided into the Northern (north of the West and East Foreland) and Central Districts (south of the Forelands to Anchor Point Light). Species commercially harvested in upper Cook Inlet include all five pacific salmon species (drift and set gillnet), eulachon or smelt (dipnet), Pacific herring (gillnet), and razor clams (hand-digging); however, sockeye salmon are the most economically valuable (ADF&G 2017b) (Shields and Dupuis 2017).

In 2016, approximately 3.0 million salmon were harvested commercially in upper Cook Inlet, which is under the average annual harvest from 1966-2016 (3.5 million salmon) (Shields and Dupuis 2017). Approximately 95.8 tons of eulachon (100 tons is the maximum allowable harvest), 22.9 tons of herring, and 285,000 pounds of razor clams were commercially harvested in 2016 (Shields and Dupuis 2017).

Potential impacts from commercial fishing on Cook Inlet beluga, fin, and humpback whales, and western DPS Steller sea lions include harassment, gear entanglement, ship strikes, reduction of prey, and displacement from important habitat. While NMFS has numerous reports of beluga whales in the Kenai River prior to, and after the summer salmon fishing season (see section 7.1), they have not been observed in the Kenai River in recent times when salmon runs are strong and fishing activity (commercial, recreational, and personal use) are high ((Shelden et al. 2015a, Shelden et al. 2015b, Castellote et al. 2016a) (also, see Figure 25 in section 7.1). There is strong indication that these whales are dependent on access to relatively dense concentrations of high value prey species throughout the summer months. A significant reduction in the amount of available prey may impact their ability to accumulate sufficient food energy, with subsequent potential impacts on both survival and productivity, which may delay or preclude recovery.

Four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole constitute the most important food sources for Cook Inlet beluga whales as identified through research and as indicated by the traditional knowledge of Alaska Natives who hunted these whales. Cook Inlet beluga whale stomachs were analyzed, and these species constitute the majority of consumed prey by weight during the summer and ice free periods. One of the PBFs included in the critical habitat designation for Cook Inlet beluga whales (PBF 2) includes “primary prey species consisting of four species of

Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole" (50 CFR §226.220(c)(2)). All prey species listed as the second PBF exist in the action area. These fish species form the foundation of Cook Inlet beluga critical habitat PBF 2.

The Alaska Department of Fish and Game has management responsibility for most of the commercial fisheries in Cook Inlet, with the exception of halibut and a few federally managed fisheries in Lower Cook Inlet. The state-managed fisheries in the upper and mid-Cook Inlet include salmon (both set and drift gillnet), herring (gillnet), a recently reopened dip net fishery for eulachon (a.k.a. hooligan or smelt), and a razor clam fishery. The largest fisheries in Cook Inlet, in terms of participant numbers and landed biomass, are the State-managed salmon drift and set gillnet fisheries concentrated in the Central and Northern Districts in the upper and mid-Cook Inlet.

Even though all five types of Pacific salmon are caught in Upper Cook Inlet, sockeye salmon is the primary target of the salmon commercial fisheries. Times of operation change depending upon management requirements, but in general the drift fishery operates from late June through August, and the set gillnet fishery during June through September. Salmon fishery effort varies between years, and within-year effort can be temporally and spatially directed through salmon management regulations. While the number of permits fished in Cook Inlet salmon gillnet fisheries has been relatively constant, the actual number of fish caught has fluctuated greatly during the past 20 years (ranging from a high of 10.6 million in 1992 to a low of 1.8 million in 2000). The 2007 commercial harvest of salmon in upper Cook Inlet was 3.6 million, slightly higher than the 10 year average of 3.5 million harvested salmon. Chinook salmon returns to much of Alaska's waters have declined precipitously in recent years. Returns of these salmon in Cook Inlet have been hard-hit, leading to closures to both sport and commercial fisheries in 2012.

The sac roe herring fisheries are located in four subdistricts of the upper and mid Inlet (Upper, West, Kalgin Island, and Chinitna Bay subdistricts); however, the Upper subdistrict fishery is the most productive one. In 2007, the herring catch was 26,000 pounds. The commercial razor clam fishery off the west side of the Inlet is the only remaining commercial fishery for razor clams in Alaska and takes about 400,000 pounds per year (Pers. Comm. J. Fox, ADF&G 2008).

There has been a sporadic fishery for eulachon (smelt) since 1978 (taking between 300-100,000 pounds in 1978, 1980, 1998, and 1999). NMFS made recommendations to the Board of Fisheries (BOF) to discontinue this fishery effective in 2000, in part due to the lack of data on the eulachon runs into the Susitna River and due to the absence of any evaluation of the effect of this fishery on beluga whales in terms of disturbance/harassment or competition for these fish. Additionally, it was noted beluga whales may be heavily dependent on the oil-rich eulachon early in the spring (preceding salmon migrations) and that large eulachon runs may occur in only a few upper Inlet streams. The commercial fishery for eulachon was reopened in 2005, but is restricted to hand-operated dip nets in saltwater between the Chuit River and the Little Susitna River, with a total harvest of 100 tons or less. From 2006-2016, commercial harvest of eulachon has ranged from 39.1 to 107 tons harvested on 3-11 permits (Shields and Dupuis 2016).

The term incidental take in regards to commercial fishing typically refers to the catch or entanglement of animals that were not the intended target of the fishing activity. Marine mammal injury or mortality reports incidental to commercial fishing operations in Cook Inlet have been obtained from fisheries reporting programs (self-reporting or logbooks), observer programs, and reports in the literature. Murray and Fay (1979) stated that salmon gillnet fisheries in Cook Inlet caught five beluga whales in 1979. Incidental take rates by commercial salmon gillnet fisheries in the Inlet were estimated at three to six beluga whales per year during 1981 – 1983 (Burns and Seaman 1986). Neither report, however, differentiated between the set gillnet and drift gillnet fisheries. There have been sporadic reports over the years of a single beluga whale becoming entangled in fishing nets (drift net and set gillnet); however, mortalities could not be confirmed.

NMFS placed observers in the commercial Cook Inlet salmon drift net and upper and lower Inlet set gillnet fisheries in 1999 and 2000. During the two years of observations, only three beluga whale sightings occurred, and no beluga whale injuries or mortalities were reported. Furthermore, during the period 1990 through 2000, fishermen's voluntary self-reports indicated no beluga whale mortalities from interactions with commercial fishing.

Fisheries that compete with Cook Inlet beluga whales and Steller sea lions for prey species can potentially impact the conservation value of critical habitat if prey availability is significantly altered (including altering access to that prey). Any diminishment in the ability for belugas or Steller sea lions to reach or utilize feeding habitat, or reductions in the amount of available prey, may impact the ability of these animals to obtain sufficient calories to survive and reproduce, and may diminish the conservation value of their designated critical habitat (NMFS 2011a, NMFS 2016d).

The potential impact of competition with groundfish fisheries in Alaska, through a reduction in the amount and quality of Steller sea lion prey species, has caused considerable debate among the scientific community. The primary issue of contention is whether fisheries reduce Steller sea lion prey biomass and quality at local and/or regional spatial scales that may lead to a reduction in Steller sea lion survival and reproduction, and, if sustained, their carrying capacity. The effect of fisheries on the distribution, abundance, and age structure of the Steller sea lion prey field, at the spatial scale of foraging sea lions and over short and long temporal scales, is largely unknown (NMFS 2008b). NMFS and the ADF&G will continue to manage fish stocks and monitor and regulate fishing in Cook Inlet to maintain sustainable stocks.

5.9 Direct Mortality

Within the action area there are several potential sources of direct mortality, including shooting, strandings, fishery/gear/debris interactions, vessel collisions, predation, and research activities.

Subsistence Harvest

The ESA and MMPA allow for the harvest of marine mammals by Alaska Natives for subsistence purposes and for traditional handicrafts. There are no reported takes of humpback whales by subsistence hunters in Alaska or Russia for the 2007- 2011 period (Muto et al. 2017a). Except for 11 Arctic villages that have International Whaling Commission-issued quota for harvest of bowhead whales, subsistence hunters in Alaska are not authorized to take large whales. However, one humpback whale was illegally harvested in Kotlik in October, 2006, and another was illegally harvested in Toksook Bay in May, 2016, while a gray whale was harvested in the Kuskokwim River in July, 2017. Low levels of unreported minke whale subsistence harvest likely occur elsewhere in remote rural Alaska. Average annual subsistence take of western DPS Steller sea lions from 2004-2008 (the only time for which region-wide estimates are available) was 136.9, with an additional average of 35.3 struck and lost animals (Allen and Angliss 2013). This take estimate excludes harvest from St. Paul Island, where limited data suggest a mean annual take of 199 Steller sea lions.

The effect from past subsistence harvests on the Cook Inlet beluga whale population was significant (Figure 9). While a harvest occurred at unknown levels for decades or longer, the subsistence harvest levels increased substantially in the 1980s and 1990s. Reported subsistence harvests during 1994-1998 probably account for the stock's decline during that interval. In 1999, beluga whale subsistence harvest discontinued as a result of both a voluntary moratorium by the hunters and Public Law 106-553, which required hunting of Cook Inlet beluga whale for subsistence uses by Alaska Natives be conducted pursuant to a cooperative agreement between NMFS and affected Alaska Native organizations. During 2000-2005, only five Cook Inlet beluga whales were harvested for subsistence purposes, and no harvests have occurred since then.

In the spring of 2012, a young beluga whale was found dead in an educational subsistence fishing net. While histopathology analysis determined the animal likely drowned, there were other health issues documented that may have been contributing factors (NMFS unpubl. data). Other than this recent interaction, NMFS is unaware of any beluga whales injured or killed in Cook Inlet due to personal use, subsistence, or recreational fisheries. The current rate of direct mortality from commercial fisheries in Cook Inlet appears to be insignificant and should not delay recovery of these whales.

Illegal Hunting and Harassment

Due to their distribution within the most-densely populated region in Alaska and their approachable nature, the potential for poaching beluga whales in Cook Inlet exists, but is not known to occur; no poaching incidents have been confirmed to date. NMFS maintains an enforcement presence in upper Cook Inlet, but effective enforcement of such a large area is difficult. NMFS Enforcement has investigated several reported incidences of harassment of Cook Inlet beluga whales, but there have been no resulting convictions.

Poaching and illegal harvest of Steller sea lions has historically occurred throughout their range. Western DPS Steller sea lions with suspected gunshot wounds have been found stranded on shore along the outer Copper River Delta as recently as 2016 (NMFS unpublished data).

Few illegal harvest of humpback whales have occurred (only 2 cases are known), and resulted primarily from the misperception by subsistence hunters in Western Alaska that they could harvest them legally. NMFS knows of no instances of illegal harvest of fin whales.

Stranding

Live stranding occurs when a marine mammal is caught in waters too shallow to swim in. Strandings can be intentional (e.g., to avoid killer whale predation), accidental (e.g., chasing prey into shallows then trapped by receding tide), or a result of illness or injury (NMFS 2016e). Cook Inlet beluga whales have presumably adapted at least somewhat to survive live strandings because they breed, feed, and molt in the shallow waters of upper Cook Inlet, Knik Arm, and Turnagain Arm, where extreme tidal fluctuations occur. More than 800 beluga whales stranded (alive and dead) in Cook Inlet since 1988 (NMFS unpublished data). From 1999 to 2016, 417-470 beluga whales were reported to have stranded alive in upper Cook Inlet during 24 live-stranding events. During that same 17 year period, there were 159 dead stranded belugas reported, with an average of 9.4 dead standings per year in from 2007-2017. Beluga whale stranding events may represent a significant threat to the conservation and recovery of this stock. Stranding events that last more than a few hours may result in significant mortalities.

In nearly all known cases, strandings of humpback and fin whales represent animals that died at sea of various other causes and washed ashore; we know of only one known case of a humpback whale live stranding on mud in Cook Inlet, and it eventually freed itself on an incoming tide.

Predation

Killer whales are the only natural predators for beluga whales and Steller sea lions in Cook Inlet (Allen and Angliss 2014). Beluga whale stranding events have also been correlated with killer whale presence, and Native hunters report that beluga whales intentionally strand themselves in order to escape killer whale predation (Huntington 2000). Prior to 2000, an average of one Cook Inlet beluga whale per year was observed with evidence of having been killed by killer whales, with 18 reported killer whale sightings in upper Cook Inlet during 1985-2002 (Shelden et al. 2003). During 2001-2012 only three Cook Inlet beluga whales were reported as preyed upon by killer whales (NMFS unpublished data). This is likely an underestimate, however, as preyed-upon belugas may well sink and go undetected. Killer whale predation has been reported to have a potentially significant impact on the Cook Inlet beluga whale population (Shelden et al. 2003).

The risk of predation to western DPS Steller sea lions is considered potentially high (Muto et al. 2017a), and may be one of the causes for past steep declines in population.

Fishery Interactions

Prior to the mid-1980s, the only reports of fatal takes of belugas incidental to entanglement in fishing gear in Cook Inlet are from the literature (Murray and Fay 1979, Burns and Seaman 1986). While there have been sporadic reports since the mid-1980s of single beluga becoming entangled in fishing nets, the only known mortality associated with entanglement in a fishing net was from a young CI beluga carcass recovered from a subsistence set net in 2012. Overall, the current rate of direct mortality from fisheries in Cook Inlet appears to be insignificant. There have been reports of non-lethal entanglement of CI belugas. For example, in 2005, a CI beluga entangled in an unknown object, perhaps a tire rim or a culvert liner, was photographed in Eagle Bay (McGuire et al. 2013), and another CI beluga was repeatedly photographed 2010–2013 with what appeared to be a rope entangled around the upper portion of its body near the pectoral flippers (McGuire et al. 2014). It is not known if these animals were able to disentangle themselves or if they died as a result of the entanglements (NMFS 2016e).

One incidental mortality of a fin whale was reported to NMFS due to entanglement in ground tackle of a commercial mechanical jig fishing vessel, resulting in an estimated annual mortality of 0.2 fin whales per year between 2010 and 2014 (Muto et al., 2017).

Humpback whales are also killed or injured during interactions with commercial fishing gear, although the evidence available suggests that these interactions may not have significant, adverse consequence for humpback whale populations. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada: a total of 595 humpback whales are reported to have been captured in coastal fisheries in those two provinces between 1969 and 1990 (Perkins and Beamish 1979) (Lien 1994). Of these whales, 94 are known to have died as a result of that capture, although, like fin whales, most of the animals that died were smaller: less than 12 meters in length (Lien 1994). From 1979-2008, 1,209 whales were recorded entangled, 80 percent of which were humpback whales (Benjamins et al. 2012). Along the Pacific coast of Canada, 40 humpback whales have been reported as entangled since 1980, four of which are known to have died (Ford et al. 2009, COSEWIC 2011). A photography study of humpback whales in southeastern Alaska in 2003 and 2004 found at least 53 percent of individuals showed some kind of scarring from fishing gear entanglement (Neilson et al. 2005).

During 2010-2014, mortality and serious injury of humpback whales occurred in the Bering Sea/Aleutian Islands pollock trawl fishery (1 each in 2010 and 2012) and the Bering Sea/Aleutian Islands flatfish trawl fishery (1 in 2010). The estimated average annual mortality and serious injury rate from observed U.S. commercial fisheries is 0.6 Western North Pacific DPS humpback whales in 2010-2014 (Muto et al. 2017). There are no known occurrences of fishery-related take of humpback whales in the action area.

The most recent minimum total annual mortality of western DPS Steller sea lions associated with commercial fisheries is 31.5 individuals (NMFS 2014). Results from a study conducted in the Aleutian Islands during June and July 1985 found that a very low percentage of observed sea lions entangled in discarded fishing net or twine, and a second study conducted during November 1986 found no entangled pups and only one entangled juvenile out of a total of 3,847 sea lions examined (NMFS 2008d). Juveniles are likely to be most vulnerable to entanglement in marine debris. Overall, the relative impact on the recovery of the WDPS of Steller sea lion due to entanglement in marine debris is ranked as low (NMFS 2008c).

An observer program for the Cook Inlet salmon set and drift gillnet fisheries was implemented in 1999 and 2000 in response to the concern that there may be significant numbers of marine mammal injuries and mortalities that occur incidental to these fisheries. Observer coverage in the Cook Inlet drift gillnet fishery was 1.75 percent and 3.73 percent in 1999 and 2000, respectively. The observer coverage in the Cook Inlet set gillnet fishery was 7.3 percent and 8.3 percent in 1999 and 2000, respectively (Manly 2006). There were no mortalities of Steller sea lions observed in the set or drift gillnet fisheries in either 1999 or 2000 (Manly 2006).

Ship Strikes

Cook Inlet beluga whales may be susceptible to ship strike mortality. To date, however, only one Cook Inlet beluga whale death, in October 2007, has been attributed to a potential ship strike based on bruising consistent with blunt force injuries (NMFS unpublished data). Beluga whales may be more susceptible to strikes from commercial and recreational fishing vessels (as opposed to large ships) because belugas and fishing boats co-occur where salmon and eulachon congregate. Beluga whales with propeller scars have been photographed in Cook Inlet, (McGuire et al. 2014), suggesting that small vessel ship strike is not rare, but such strikes are often survivable. Small boats are able to quickly approach and disturb these whales in their preferred shallow coastal habitat.

From 1978-2012, there were at least 108 recorded whale-vessel collisions in Alaska, with the majority occurring in Southeast Alaska (Neilson et al. 2012). Among larger whales, humpback whales are the most frequent victims of ship strikes in Alaska, accounting for 86% of all reported collisions. One humpback collision has been reported in the action area. Only three fin whale collisions were reported in Alaska waters during those years, and none from within the action area (Neilson et al. 2012). However, during 2015, one dead fin whale came into the Port of Anchorage on the bulbous bow of a ship traveling from Seattle, but it was unknown where the initial strike occurred (NMFS Alaska Regional Office Stranding Database accessed May 2017).

Although risk of ship strike has not been identified as a significant concern for Steller sea lions (Loughlin and York 2000), the recovery plan for this species states that Steller sea lions may be more susceptible to ship strike mortality or injury in harbors or in areas where animals are concentrated [e.g., near rookeries or haulouts; (NMFS 2008d)].

5.10 Research

Research is a necessary endeavor to assist in the recovery of most threatened and endangered species. However, research activities can also disturb these animals, especially when these activities include animal capture, drawing blood and tissue samples, or attaching tracking devices such as satellite tags. In the worst case, research can result in deaths of the animals. Research on marine mammals often requires the use of boats and/or planes to conduct surveys. Aerial surveys can disturb Cook Inlet beluga whales, especially where circling low-altitude flights are conducted to obtain accurate group counts. Boat based surveys, such as the photo-identification study, often require the boat to closely approach whales or whale groups. Deployment and retrieval of passive acoustic monitoring devices requires a boat, which temporarily increases noise in the immediate area. However, once the instruments are deployed, this type of monitoring is noninvasive.

Between 1999 and 2002, NMFS placed satellite tags on 18 beluga whales in upper Cook Inlet (Hobbs et al. 2005). Shortly after a tagging event in 2002, a beluga whale was found dead; its tag had transmitted for only 32 hours. Another two beluga whales transmitted data for less than 48 hours, with similar dive patterns; it was assumed they too had died (NMFS, unpublished data). In 2015, an additional animal previously tagged by researchers washed up dead with an infection at the site of instrument attachment.

Aerial surveys conducted by NMFS occurred every June, July, and/or August from 1993-2012, and now occur biennially. The primary goal of these surveys is to document abundance and distribution of beluga whales in Cook Inlet (Rugh et al. 2000, Rugh et al. 2005a, Rugh et al. 2005c, Rugh et al. 2006, Rugh et al. 2007, Shelden et al. 2008, Shelden et al. 2009, Shelden et al. 2010, Shelden et al. 2011, Shelden et al. 2012). Aerial surveys were also conducted every one to two months between June 2001 and June 2002 (Rugh et al. 2004). A small fix-winged aircraft is used to conduct the surveys and maintains an altitude of about 244 m [800 ft; (Rugh et al. 2005a, Hobbs et al. 2009)] to reduce in-water noise from the plane.

Since 2005, researchers from LGL Alaska Research, Inc. have photographed beluga whales in upper Cook Inlet as part of a photographic-identification project conducted for NMFS, the National Fish and Wildlife Foundation, Chevron, and Conoco Phillips Alaska, Inc. Photographs are taken from small boats and on land, and later analyzed and cataloged into an extensive database (McGuire et al. 2008, McGuire et al. 2009, McGuire et al. 2011, McGuire et al. 2013, McGuire et al. 2014, McGuire and A. 2016). In 2011, this project was expanded to include waters of the Kenai Peninsula Borough. Boat-based surveys, such as the photo-identification study, often require the boat to come within close proximity of a whale or group of whales being studied, likely increasing noise in the immediate area.

Various researchers have deployed hydrophones and collected acoustic data at and near Eagle Bay, Cairn Point (POA), Fire Island, Beluga River, Trading Bay, Kenai River, Tuxedni Bay, and Kachemak Bay [e.g., (Širović and Kendall 2009, HDR Alaska 2011, GSI 2012, Castellote et al. 2016a)]. Passive acoustic monitoring often requires a boat to deploy and recover hydrophones. The boat temporarily increases noise in the immediate area during deployment and recovery, which may cause disturbance to nearby beluga whales. However, once the instruments are deployed, this type of monitoring remains noninvasive because the recording devices are generally anchored on the seafloor or suspended in the water column passively recording sound from the environment.

Several development projects (ongoing and planned) have conducted research or monitored the presence of Cook Inlet belugas and marine mammals in their respective action area. For instance, the Knik Arm Bridge and Toll Authority (KABATA) collected baseline environmental data on beluga whale activity to be used to evaluate the potential impact of a proposed bridge crossing in Knik Arm, north of Cairn Point. Boat and land-based observations were conducted in Knik Arm from July 2004 through July 2005 (Funk et al. 2005), and in the fall of 2011, KABATA conducted a “Proof of Concept” study to test visual and acoustic methods’ abilities to detect beluga whales near the project site prior to implementing the full scale monitoring once construction begins (HDR 2011). In addition to KABATA’s studies, land-based marine mammal observers have been utilized for other development projects. For example, the POA utilized marine mammal observers during the in-water work, and sponsored research on presence and habitat use of Cook Inlet belugas near the POA’s expansion site (Cornick and Kendall 2008, Cornick and Saxon-Kendall 2009, Cornick et al. 2010). In 2009-2010, Ocean Renewable Power Company (ORPC) sponsored land-based observations from Fire Island documenting belugas near a potential hydrotidal project site (McGuire et al. 2011).

Although research could have an effect on beluga whales, it is anticipated that research will continue because there are many remaining data gaps on the biology and ecology of the Cook Inlet beluga (NMFS 2008a). Likewise, research will continue on other listed species in the action area.

There have been no known instances of research-related deaths of humpback or fin whales in the action area. Aerial surveys have the potential to affect Steller sea lions, primarily due to aircraft noise-induced sea lion stampedes that can result in the crushing of pups and young animals. Such events can occur after an aircraft has already passed by the animals. We have no knowledge of whether such stampedes associated with research have been caused within the action area.

5.11 Climate Change

Overwhelming data indicate the planet is warming (IPCC 2014), which poses a threat to most Arctic and sub-Arctic marine mammals. Cook Inlet is a very dynamic environment that experiences continual change in its physical and structural composition; there are extreme tides, strong currents, and a tremendous volume of silt input from glacial scouring.

Beluga whales seasonally breed and feed in nearshore waters during the summer, but are ice-associated during the remaining part of the year. Ice floes can offer protection from predators and, in some regions, support prey, such as ice-associated cod. Moore and Huntington (2008) suggested that belugas and other ice-associated marine mammals might benefit from warmer climates as areas formerly covered ice would be available to forage. However, given the limited winter prey available in upper Cook Inlet (where ice predominates during winter), less winter ice might not benefit Cook Inlet beluga whales.

The bigger threat of climate change to belugas may not be the direct change in climate, but rather the effect regional warming would have on increased human activity. Less ice would mean increased vessel activity with an associated increase in noise, pollution, and risk of ship strike. Other factors include changing prey composition, increased killer whale predation due to lack of ice refuge, increased susceptibility to ice entrapment due to less predictable ice conditions, and increased competition with co-predators. Specific to Cook Inlet beluga whales, the greatest climate change risks would be potential changes in salmon and eulachon abundance, and any increase in winter susceptibility to killer whale predation. Also, more rapid melting of glaciers might change the silt deposition in the Susitna Delta, potentially altering habitat for prey (NMFS 2008a). However, the magnitude of these potential effects is unpredictable, and the persistence of beluga whales within Cook Inlet since the last ice age suggests a strong resilience to environmental changes.

Whether recent increases in the presence of humpback whales in Cook Inlet can be attributed to climate change, whale population growth, or other factors remains speculative. There is no clear trend in the number of humpback whale sightings in lower Cook Inlet between 2004 and 2014 (Figure 12). Climate-driven changes in glacial melt are presumed to have profound effects on seasonal streamflow within the Cook Inlet drainage basin, affecting both anadromous fish survival and reproduction in unpredictable ways. Changes in glacial outwash will also likely affect the chemical and physical characteristics of Cook Inlet's estuarine waters, possibly changing the levels of turbidity in the inlet. Whether such a change disproportionately benefits marine mammals, their prey, or their predators is unknown.

Notable climate-driven changes are not expected to be measurable over the 5 years of oil and gas exploration associated with this first incremental step. However, we note that any developed wells that may result from this project will facilitate the release of many tons of geologically-sequestered carbon emissions into the atmosphere, exacerbating the on-going problem of climate change. Climate change is not, however, expected to increase or decrease the effects of this particular action on listed species in the foreseeable future.

An Unusual Mortality Event (UME) of large cetaceans occurred in Alaska waters in 2015-2016, including portions of the action area. Reports of dead whales included 22 dead humpback, 12 fin, 2 gray, 1 sperm, and 6 unidentified whales. The fin whales were observed stranded within a 27-day period around Kodiak Island. This was concurrent with an unusually large number of dead whales found in British Columbia, which included 6 humpback, 5 fin, and 1 sperm whale (NMFS unpublished data). The strandings were concurrent with the arrival in Alaskan waters of a persistent but anomalous ocean surface heat region dubbed “the Blob,” which extended to depths of 200 m, potentially affecting whale food resources. The mortalities were also concurrent with one of the strongest El Nino weather patterns on record, decreasing ice extent in the Bering Sea, and the second warmest year on record in Alaska in terms of air temperature. While we cannot say with certainty that this UME was caused or exacerbated by climate change, it remains a reasonable hypothesis.

Cook Inlet beluga whale and Steller sea lion critical habitats may be affected by climate change and other large-scale environmental phenomena including Pacific Decadal Oscillation (PDO) (a long-lived El Nino-like climate variability that may persist for decades) and ecological regime shifts. Climate change can potentially affecting prey availability, glacial output and siltation, and salinity and acidity in downstream estuarine environments (NMFS 2010b; NMFS 2015a, NMFS 2016d). PDO may influence rainfall, freshwater runoff, water temperature, and water column stability. Ecological regime shifts, in which species composition is restructured, have been identified in the North Pacific (Anderson and Piatt, 1999; Hare and Mantua, 2000; Hollowed and Wooster, 1992; Spies, 2007) and are believed to have affected prey species availability in Cook Inlet and the North Pacific. These events may result in seasonal and spatial changes in prey abundance and distribution and could affect the conservation value of designated critical habitat for Cook Inlet beluga whales and Steller sea lions.

5.12 Natural Catastrophic Changes

The critical habitats for Cook Inlet beluga whales and Steller sea lions are within a region of known seismic and volcanic activity and tsunami events. Earthquakes, volcanic eruptions, landslides, and tsunamis can alter the physical environment instantaneously. Catastrophic events are infrequent but have the potential to substantially affect Cook Inlet beluga and Steller sea lion critical habitat by: decreasing prey abundance as a result of direct mortality; rendering habitat unsuitable for Cook Inlet beluga and Steller sea lion prey species; directly removing habitat areas (e.g., elevation changes, landslides, and tsunamis could remove haulouts and rookeries or block access to critical habitat); and degrading habitat quality (e.g., volcanic ash outfall could affect siltation and water chemistry) (NMFS 2016d).

5.13 Summary of Stressors Affecting Listed Species in the Action Area

Several of the activities described in the *Environmental Baseline* have adversely affected listed species and designated critical habitat that occur in the action area:

- Coastal development (Figure 20), particularly at the Port of Anchorage, has resulted in exposure of a small number of beluga whales to noise levels capable of causing harassment.

- Oil and gas development (Figure 20) has resulted in 76 spills releasing 10,500 gallons of oil into Cook Inlet since 1962. However, only 5 of those 76 spills, totaling 6 gallons, occurred during oil exploration. Of the spills that occurred during production, three spills exceeded 200 gallons.
- Seismic exploration introduces sounds up to 237 dB into the marine environment, creating a 9.5 km-radius zone in which sound was sufficiently loud to cause harassment. Seismic exploration has resulted in Level A noise exposure to both humpback and beluga whales in small numbers. It has also resulted in the temporary degradation of Cook Inlet Beluga whale critical habitat.
- Aircraft have been observed to cause behavioral changes to groups of feeding beluga whales when the aircraft flew past at low altitudes or circled the groups.
- Fisheries co-occur with concentrations of beluga prey (Figure 20), likely competing with the whales for their prey (Figure 25). Beluga whales no longer avail themselves of abundant but heavily exploited salmon runs off the Kenai River during summer as they once did. Propeller scars observed on belugas may have resulted from collisions with recreational or commercial fishing boats. Commercial fisheries may have resulted in degradation of Cook Inlet beluga whale critical habitat by reducing prey availability.
- Commercial whaling in the 19th and early 20th centuries reduced large whale populations in the North Pacific down to a fraction of historic population sizes.
- Subsistence whaling for Cook Inlet beluga whales by Alaska Natives represents the largest known human-related cause of mortality for the stock, reducing the population from about 1,300 whales in 1979 to near the current level of about 328 whales. The population has remained in slow decline following the 2005 moratorium on hunting.
- Average annual subsistence take of western DPS Steller sea lions from 2004-2008 (the only time for which region-wide estimates are available) was 136.9, with an additional average of 35.3 struck and lost animals (Allen and Angliss 2013). This take estimate excludes animals taken on St. Paul Island, where limited data suggest a mean annual take of 199 animals.
- Numerous incidents of vessel collisions with large whales, predominately humpbacks, have been documented in Alaska since 1978, primarily in southeast Alaska. Strikes have involved cruise ships, recreational cruisers, whale watching catamarans, fishing vessels, and skiffs.
- Shipping activities in Cook Inlet (Figure 19) pose varying levels of threats to the species depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with habitats. The presence and movements of ships in the vicinity of some species may cause them to abandon breeding or foraging areas
- Whether contaminants have resulted in the degradation of Cook Inlet beluga whale critical habitat remains unknown. Contaminant loads in Cook Inlet beluga whales are low compared to other stocks.
- Wastewater is discharged into Cook Inlet, much of it untreated or undergoing only primary treatment. Effects of this discharge on marine mammals remain unknown.

- At least three Cook Inlet beluga whales died shortly after attachment of satellite transmitters to their backs. Mortalities incidental to marine mammal research activities in the action area appears to be low.
- Currently, there are insufficient data to make reliable estimations of the effects of Arctic climate change on baleen whales. The feeding range of fin whales is larger than that of other species and consequently, as feeding generalists, it is likely that the fin whale may be more resilient to climate change than other species with more restricted foraging habits. Effects of climate change and other large scale environmental phenomena (e.g. PDO) on Steller sea lion and Cook Inlet beluga whale critical habitat remain unknown.
- The beluga whale has undergone notable summer range restriction in recent years, where whales now concentrate to a greater extent in upper Cook Inlet (Figure 7).

Populations of fin whales, western North Pacific DPS and Mexico DPS humpback whales, and Steller sea lions within the action area appear to be stable or increasing, despite their continued exposure to the direct and indirect effects of the activities discussed in the *Environmental Baseline*.

Although we do not have information on other measures of the demographic status of these species (for example, age structure, gender ratios, or the distribution of reproductive success) that would facilitate a more robust assessment of the probable impact of the *Environmental Baseline*,[12] we infer from their increasing abundance that the *Environmental Baseline* is not currently preventing the populations of these species from increasing. However, the Cook Inlet beluga whale population continues to decline for unknown reasons.

[12] Increase in a population's abundance is only one piece of evidence that a population is improving in status; however, because populations can increase while experiencing low juvenile survival (e.g., if low juvenile survival is coupled with reduced adult mortality) or when those individuals that are most sensitive to a stress regime die, leaving the most resistant individuals, increases in abundance are not necessarily indicative of the long-term viability of a species.

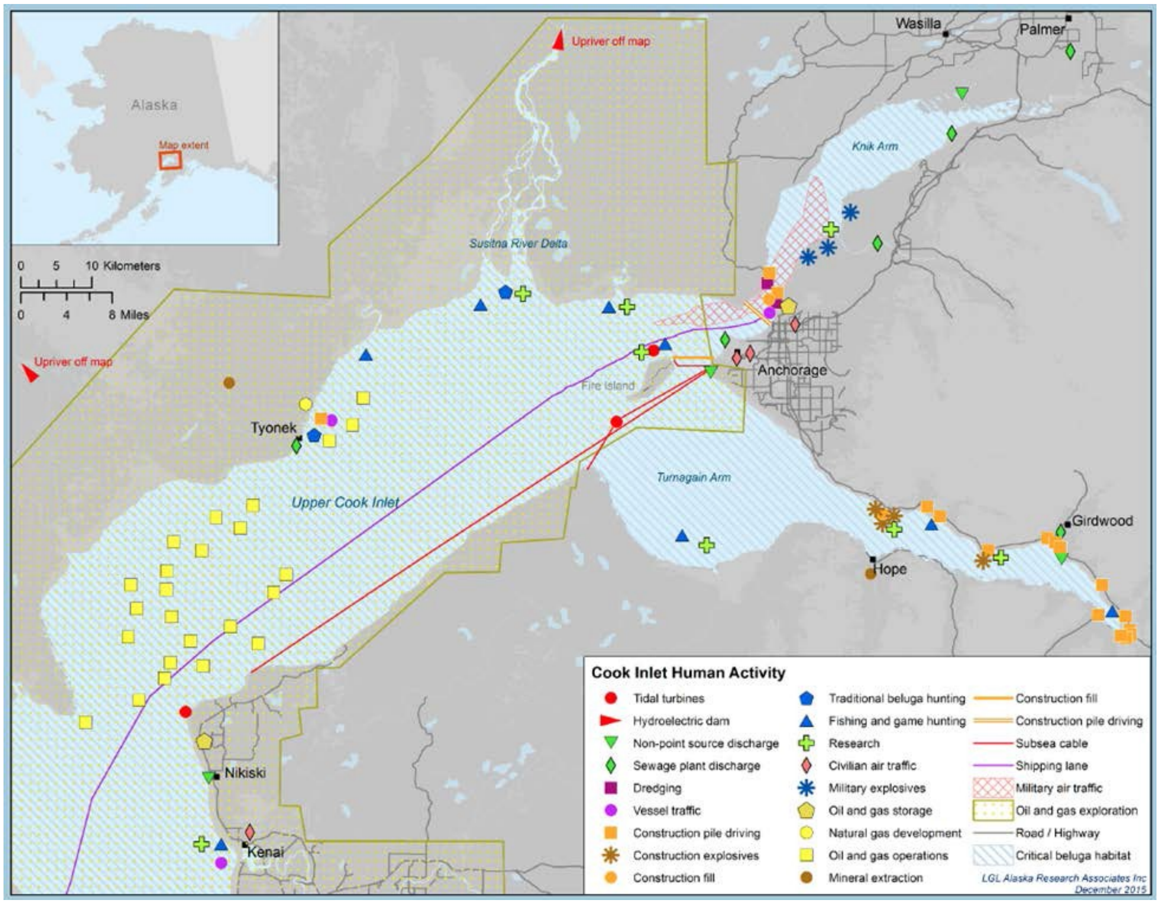


Figure 20. Development and anthropogenic activities in Cook Inlet Area (LGL 2015, unpublished data).

6 EFFECTS OF THE ACTION

“Effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR §402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

This biological opinion relies on the best scientific and commercial information available. We try to note areas of uncertainty, or situations where data are not available. In analyzing the effects of the action, NMFS gives the benefit of the doubt to the listed species by minimizing the likelihood of false negative conclusions (concluding that adverse effects are not likely when such effects are, in fact, likely to occur).

We organize our effects analysis using a stressor identification – exposure – response – risk assessment framework for the proposed exploration activities. Then we provide a description of the potential effects of development, production, and decommissioning that could arise from leases issued by BOEM / BSEE in LS 244 as those effects are currently understood. Future incremental steps (development, production, and decommissioning) are not considered reasonably certain to occur and would require additional NEPA analysis and additional consultation under the ESA.

We conclude this section with an *Integration and Synthesis of Effects* that integrates information presented in the *Status of the Species* and *Environmental Baseline* sections of this opinion with the results of our exposure and response analyses to estimate the probable risks the proposed action poses to endangered and threatened species.

The MMPA defines “harassment” as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (16 U.S.C. §1362(18)(A)).

While the ESA does not define “harass,” NMFS recently issued guidance interpreting the term “harass” under the ESA to mean to “create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering” (Wieting 2016).

6.1 Effects of the First Incremental Step

The first incremental step consists of activities associated with exploring and delineating a prospect on a block acquired during LS 244 [marine seismic, shallow geohazard, geotechnical surveys, and exploratory drilling (years 1-5)].

6.1.1 Project Stressors

Stressors are any physical, chemical, or biological phenomenon that can induce an adverse response. The effects section starts with identification of the stressors produced by the constituent parts of the proposed action. Based on our review of the data available, the proposed oil and gas exploration activities may cause these primary stressors to marine mammals:

1. Acoustic stressors; impulsive: 2D/3D seismic surveys, geohazard surveys, VSP and pile driving;
2. Acoustic stressors; non-impulsive: vessels, aircraft, and drilling and pumping operations;
3. Risk of vessels striking marine mammals;
4. Seafloor disturbance from drilling activities and placement of equipment or anchors;
5. Introduction of trash and debris that may cause entanglement or harm through ingestion; and
6. Pollution from unauthorized spills.

While this opinion next focusses on these primary stressors to marine mammals, all potential stressors from the proposed action were considered.

6.1.2 Acoustic Thresholds

As discussed in Section 2, *Description of the Proposed Action*, BOEM/BSEE intend to authorize oil and gas leasing and exploration activities (marine seismic, geohazard, and geotechnical surveys, and exploratory drilling) (Table 1).

Since 1997, NMFS has used generic sound exposure thresholds to determine whether an activity produces underwater and in-air sounds that might result in impacts to marine mammals (70 FR 1871, 1872; January 11, 2005). NMFS recently developed comprehensive guidance on sound levels likely to cause injury to marine mammals through onset of permanent and temporary thresholds shifts (PTS and TTS; Level A harassment) (81 FR 51694; August 4, 2016). NMFS is in the process of developing guidance for behavioral disruption (Level B harassment). However, until such guidance is available, NMFS uses the following conservative thresholds of underwater sound pressure levels[13], expressed in root mean square[14] (rms), from broadband sounds that cause behavioral disturbance, and referred to as Level B harassment under section 3(18)(A)(ii) of the Marine Mammal Protection Act (MMPA):

- impulsive sound: 160 dB re 1 μPa_{rms}
- continuous sound: 120 dB re 1μPa_{rms}

Under the PTS/TTS Technical Guidance (NMFS 2016f), NMFS uses the following thresholds for underwater sounds that cause injury, referred to as Level A harassment under section 3(18)(A)(i) of the MMPA (Table 16). These acoustic thresholds are presented using dual metrics of cumulative sound exposure level (L_E) and peak sound level (PK) for impulsive sounds and L_E for non-impulsive sounds:

[13] Sound pressure is the sound force per unit micropascals (μPa), where 1 pascal (Pa) is the pressure resulting from a force of one newton exerted over an area of one square meter. Sound pressure level is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure level in acoustics is 1 μPa, and the units for underwater sound pressure levels are decibels (dB) re 1 μPa.

[14] Root mean square (rms) is the square root of the arithmetic average of the squared instantaneous pressure values.

Table 16. PTS Onset Acoustic Thresholds for Level A Harassment (NMFS 2016f).

	PTS Onset Acoustic Thresholds* (Received Level)	
Hearing Group	**Impulsive**	**Non-impulsive**
Low-Frequency (LF) Cetaceans	$L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	$L_{E,LF,24h}$: 199 dB
Mid-Frequency (MF) Cetaceans	$L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	$L_{E,MF,24h}$: 198 dB
High-Frequency (HF) Cetaceans	$L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	$L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	$L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	$L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	$L_{pk,flat}$: 232 dB $L_{E,OW,24h}$: 203 dB	$L_{E,OW,24h}$: 219 dB

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1µPa²s. The subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

Level A harassment radii can be calculated using the optional user spreadsheet[15] associated with NMFS Acoustic Guidance, or through modeling.

In addition, NMFS uses the following thresholds for in-air sound pressure levels from broadband sounds that cause Level B behavioral disturbance under section 3(18)(A)(ii) of the MMPA:

[15] The Optional User Spreadsheet can be downloaded from the following website: http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm

- 100 dB re 20µPa$_{rms}$ for non-harbor seal pinnipeds

As described below, we anticipate that exposures to listed marine mammals from noise associated with the proposed action may result in disturbance and potential injury. However, no mortalities or permanent impairment to hearing are anticipated due to the implementation of standard mitigation measures. However, future section 7 consultations and future issuance of IHAs or LOAs may authorize such takes.

6.1.3 Exposure Analysis

As discussed in the *Approach to the Assessment* section of this opinion, exposure analyses are designed to identify the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Because we lack specifics about the exact nature of these effects (e.g., intensity of noise at a given distance from the source), we strive in this section to present reasonable estimates of take using the best available information, noting that NMFS considers that an individual animal can be taken once per day by a given source.

6.1.3.1 Exposure and Take Due to Major Noise Sources

Activity Definitions

BOEM/BSEE projected a level of exploration activities during the first incremental step based industry's stated needs for exploring those leases. Although the levels of activities can be estimated, the particular strategy used by a company regarding when and where to explore for resources may change depending on what a company found during previous exploration activities, as well as market factors and changes in technology. Therefore, predicting and planning for levels of activity over a longer period of time (i.e. three or more years in the future) can be difficult. While NMFS and BOEM can estimate the level of future activity on an annual basis, there is some uncertainty in projections beyond that point.

Due to the number of surveys and survey types expected to result from LS 244, precise calculations associated with specific airgun arrays are impractical. Instead a "typical marine seismic array" and "typical geohazard seismic array" has been defined based on an analysis of previous airguns recently utilized in the Cook Inlet operations (reports are available on past Arctic oil and gas projects on NMFS's website: http://www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm). The two marine seismic operations are anticipated to use a 2,400 in^3 airgun array with a 238 dB re 1 µPa rms source level. Geohazard seismic surveys are likely to be conducted with smaller arrays (e.g. 400 in^3, but BOEM requested that NMFS consider use of up to 2400 in^3 arrays for this purpose. We made a similar assumption for VSP operations, although similar drilling operations in Alaska's Chukchi Sea used a 500 in^3 array with a source level of 228 dB re 1 µPa rms (see Table 3 for additional information). Actual array output varies by seismic survey type and can be higher or lower depending on the number of arrays and airguns used. This could result in an increase or decrease of the ensonified area.

Level of Activity

For the first incremental step, we anticipate the following level of activity on LS 244, based upon the maximum amount of activity presented by BOEM/BSEE in their Biological Assessment (BOEM 2017b) (Table 17):

- Maximum total of **two** 2D/3D marine seismic surveys (towed streamer, OBN, or OBC) during the first two years;
- Maximum total of **five** geohazard surveys during the first three years;
- Maximum total of **five** geotechnical surveys during the first three years;
- Maximum of **two** drilling rigs/drillships per year, and a maximum total of **eight** during the five years;
- Maximum of **three** exploration/delineation wells per rig drilled per year (total of up to six wells per year for two rigs), and a maximum total of **10** wells drilled during the first five years;
- Maximum of **six** vertical seismic profiling surveys per year, and a maximum total of **10** vertical seismic profiling surveys during the first five years; and
- Maximum of **three** oil spill drill exercises per year, with a maximum total of **15** spill drills during the first five years.

In addition, we considered the take that would result from drillship activity in the event that drillships are used instead of jack-up rigs. We also considered the effects of pile driving associated with jack-up rigs, as has been the practice with recent use of jack-up rigs in Cook Inlet.

Table 17. Activity Definitions Anticipated for the First Incremental Step

Activity/Program	# of source vessels	# of support vessels	Type of Energy/Sound Sources Used	Duration (days)	Months for each activity	Activity Area and/or # of Wells Drilled
3D Marine Towed Streamer Seismic Survey	1 Source/ Receiver Vessel	1 support vessel 1 vessel for monitoring	Source array typically consists of one or more sub-arrays of 6-8 airgun sources each Individual airgun size: 10-150 in^3 Airgun array range from 1,200-2,400 in^3	60/survey	March - December	3D 200 mi^2 (100 km^2) per season
3D Ocean Botton Node Seismic Survey	1-2 Source vessels	2 node layout/pick up vessels 1-3 small utility boats	Source array typically consists of one or more sub-arrays of 6-8 airgun sources each Individual airgun size: 10-150 in^3 Airgun array range from 1,200-2,400 in^3	60/survey	March - December	200 mi^2 (518 km^2) per season
3D Ocean Botton Cable Seismic Survey	1-2 Source vessels 1 Receiver vessel	2 node layout/pick up vessels 1-3 small utility boats	Source array typically consists of one or more sub-arrays of 6-8 airgun sources each Individual airgun size: 10-150 in^3 Airgun array range from 1,200-2,400 in^3	60/survey	March - December	200 mi^2 (518 km^2) per season
Geotechnical	1 vessel or drilling barge		Subsurface sediment collection	60	March - December	10
Geohazard Site Clearance and High-Resolution Shallow Hazard Surveys	1 Source/ Receiver vessel	1- support vessels	Four, 10 in^3 (0.16 liter) airguns Multi-beam echosounders Sub-bottom profilers Side-scan sonars	20-30	March - December	~80 line miles per site ~400 line miles per site survey ~881 line miles per pipeline survey
Vertical Seismic Profiling	1 Source/ Receiver vessel		Airgun array range from 40-500 in^3	1 day per well for VSP	March - December	Up to 10
Exploratory Drilling Program (from a jackup rig)	2 jackup rigs	3 tug boats/rig 2 support vessels/rig Aircraft for crew changes	Drill	60/well 180 days per year	March-December	10
Pile driving for jack-up rig	2 jack-up rigs		Pile driving	1/well	March-December	10

Assumptions

Assumptions about the defined activities in the first incremental step are noted in Table 18. We assumed the ensonified area for each activity does not intersect with land and consists entirely of ocean. Because we do not know the locations of the ten proposed exploration wells, we cannot perform any GIS-based overlays upon Alaska shoreline data layers to excise land from the ensonified areas, often leading to an overestimate in total ensonified area.

This opinion focuses on oil and gas exploration activities (marine seismic, geohazard, and geotechnical surveys, and exploratory drilling and associated activities) on the active leases within Lease Sale 244 in Cook Inlet. Off-lease seismic operations are outside the scope of the proposed action, but are subject to potential separate ESA section 7 consultations. Seismic work in Cook Inlet has traditionally been conducted during the ice-free months of April through November. Each seismic survey takes up to 90 days, depending on environmental conditions, equipment operations, size of area to be surveyed, and other factors (Jacobs Engineering 2017). Typically, data are not collected between 25% and 30% of the time because of equipment or weather problems. Because of the limited time period of open water, it is likely that concurrent surveys would be conducted in the same general time frame and may overlap in time, but will not overlap in space (i.e. within a minimum of approximately 24 km [15 mi] of each independent survey operation) for reasons regarding data integrity. Drilling operations are anticipated to take between 30 and 60 days at each well site (BOEM 2017b) for a maximum total of 600 days during the First Incremental Step.

NMFS anticipates the following probability of occurrence for humpback whale DPSs in the action area: Hawaii DPS 89%, Mexico DPS 10.5%, and Western North Pacific DPS 0.5% (NMFS 2016c, Wade et al. 2016).

Table 18 and Table 19 contain a representative summary of take that were predicted to occur in Cook Inlet for each listed species based on activity scenarios provided by BOEM, and density and noise propagation information associated with recent oil and gas activity in Cook Inlet. Having determined the duration of each activity and its ensonified area on a per-day basis, we multiply this by the expected density of each species in the action area to arrive at the number of expected instances of take per species.

Mitigation Measures to Minimize the Likelihood of Exposure to Major Noise Sources

Mitigation measures are described in detail in Section 2.5. The following mitigation measures will be required through the MMPA permitting process to reduce the adverse effects of exposure to major noise sources on marine mammals from the proposed oil and gas exploration activities.

1. PSOs are required on all vessels engaged in seismic survey, pile driving, anchor handling, drillship drilling, and dynamic positioning activities that may result in incidental take through acoustic exposure.

2. Establishment of radii associated with received sound level thresholds for Level A shutdown/power down for marine mammals under NMFS's authority, including the use of

PSOs to monitor for, and take steps to minimize occurrence of, marine mammals within Level A harm and Level B harassment zones for seismic survey, pile driving, anchor handling, drillship drilling, and dynamic positioning activities that may result in incidental take through acoustic exposure.

3. Use of start-up, power-up and ramp-up procedures for airgun arrays.

4. Time/area restrictions for seismic survey operations to avoid Cook Inlet beluga aggregations.

Approach to Estimating Exposures to Major Noise Sources

We lack much of the information needed to accurately estimate take of listed animals due to exposure to noise associated with this action. We lack accurate source levels for equipment, as well as how noise from this equipment will propagate within the lease sale area. We also lack refined density estimates for potentially exposed marine mammal species throughout the duration of this action. Therefore, our estimates of take represent our first best estimate given the best available information we have. Subsequent biological opinions for ancillary activities and future incremental steps may contained refined take estimates as additional information is obtained.

Our initial take estimates do not take into account the possibility of multiple exposures of a single animal to different sources of take on the same day. In addition, applying a single density estimate derived from June aerial surveys to our take calculations does not adequately account for densities variations in Cook Inlet across space and time for any of the species. While some animals may remain in close proximity to project activities for prolonged periods of time, others may simply transit through the area and others may not occur near project activities at all if they remain in upper Cook Inlet throughout the year. However, given the best available information, we consider the estimates of take reflected in Table 18 and Table 19 to be our best estimates of take at this time.

The exposure analysis assumes the following will occur during the first incremental step: two 2D/3D seismic surveys, 5 geohazard surveys, 5 geotechnical surveys, 10 vertical seismic profiling surveys, 10 drilling operations, 13 drill rig movements, and 15 oil spill drills.

Table 18 indicates that, for the scenario where drilling occurs from jack-up rigs, about 160 Cook Inlet beluga takes by harassment may occur as a result of activities associated with the first incremental step of this action, with the vast majority of these takes (150) resulting from seismic exploration. Similarly, we estimate 379 total instances of take of humpback whales, 0.5% of which are anticipated to be Western North Pacific DPS humpback whales (2 animals), 10.5% of which are anticipated to be Mexico DPS humpbacks (40 animals), with the remaining takes occurring for non-listed Hawaii DPS animals. Fifty two instances of fin whale take and 1,282 instances of Western DPS Steller sea lion take to Level B harassment levels are also expected.

In Table 19, we assume the use of drillships, and estimate that 305 instances of beluga whale take will occur, as well as 724 instances of humpback whale take (4 Western North Pacific DPS humpbacks and 76 Mexico DPS humpbacks), 99 instances of fin whale take, and 2,452 instances of Steller sea lion take.

Note that Tables 18 and 19 present estimates of Level B exposures from project activities, but these estimates are not numbers of authorized take. Authorized take will be calculated and provided in incidental take statements, if appropriate, during future consultations. At that juncture, BOEM, BSEE, and NMFS will have more complete and detailed information on the specific number, location, timing, frequency, and intensity of actions associated with subsequent exploration, development, production, and decommissioning activities.

Separately, note that the estimates presented below all represent take due to Level B behavioral exposures and assume no injury (or mortality) based on previous analyses using historical Level A harassment thresholds and assumptions about avoidance and mitigation. As described above, future authorization and calculations using the revised auditory impact thresholds for Level A take (see Section 6.1.2) will likely not result in much of a change to predicted numbers, but it is not appropriate to rule out the chance of PTS completely, so there may be cases in the future, on a site specific basis, in which NMFS authorizes a small number of Level A harassment takes for species other than Cook Inlet beluga whales. However, if so, it would not change the estimated exposure numbers in Table 18 and Table 19, as those Level A harassment takes would come from the pool of takes that would otherwise have been estimated as Level B harassment in those tables. At this time, we anticipate that any number of Level A takes would be small, and so we do not expect that the small number of Level A takes that may result from this action will have any measurable effects upon listed species populations. We also emphasize here that not all exposures are biologically significant and may not rise to the level of harassment under the ESA as set forth in NMFS guidance (Wieting 2016). Additional contextual analysis is needed, and typically only some portion (depending on the circumstances and context of the exposures) of any estimated exposures have the potential or likelihood of affecting animal fitness.

Table 18. Estimated instances of take of listed marine mammals due to received sound levels ≥120 dB re 1 µPa (rms) for continuous noise, or ≥160 dB re 1 µPa (rms) for impulsive noise associated with BOEM/BSEE total oil and gas exploration authorizations under the First Incremental Step. Fractional takes rounded up.

Action (I = impulsive, N= nonimpulsive)[1]	Source level (dBRMS re 1 µPa @ 1 m)	Instances	duration per instance (days)	total duration	ensonified area radius (km)	Area ensonified per day (km2)	Densities				Estimated take			
							Humpback	Fin	Cook Inlet Beluga	WDPS Steller Sea Lion	Humpback take	Fin take	Beluga take	WDPS SSL take
Seismic surveys (I)[2]	238	2	90	180	9.5	784	0.00251	0.000343	0.00106	0.0085	354.2112	48.40416	149.5872	1199.52
Vertical Seismic Profiling (I)[3]	228	10	1	10	9.5	458	0.00251	0.000343	0.00106	0.0085	11.4958	1.57094	4.8548	38.93
Geotechnical (I)[4]	158	5	2	10	0.34	0.363168111	0.00251	0.000343	0.00106	0.0085	0.00911552	0.001245667	0.003849582	0.030869289
Geohazard (I)[5]	230	5	2	10	9.5	283.528737	0.00251	0.000343	0.00106	0.0085	7.116571298	0.972503568	3.005404612	24.09994264
Pile driving (I)[6]	216	10	1	10	5.4	91.60884178	0.00251	0.000343	0.00106	0.0085	2.299381929	0.314218327	0.971053723	7.786751551
Drilling (N)[7]	158	10	60	600	0.34	0.363168111	0.00251	0.000343	0.00106	0.0085	0.546931175	0.074739997	0.230974918	1.852157365
Movement of Drill Rigs (N)[8]	170	13	1	13	2.1	88	0.00251	0.000343	0.00106	0.0085	2.87144	0.392392	1.21264	9.724
Total											378.5504399	51.73019956	159.8659228	1281.943721

[1]For impulsive noise sources, the area ensonified extends outward to the 160 dB isopleth. For non-impulsive noises, the area ensonified extends outward to the 120 dB isopleth.
[2]Seismic exploration area ensonified per day assumes a 9 km x 9 km patch surveyed per day and a 9.5 km radius ensonified zone around that patch.
[3]Vertical seismic profiling assumes acoustic impacts no greater than recent Cook Inlet 3D seismic surveys (9.5 km radius ensonified zone) and a 2400 x 2400 m area.
[4]Assumes geotechnical and drilling are equal in acoustic output.
[5]Geohazard source level from BOEM 2016a.
[6]Pile driving source level from NMFS 2017.
[7]Sound source level from BOEM 2016a.
[8]Drill rig movement based upon assumed average distance of transport = 40 km.

Table 19. Estimated instances of take of listed marine mammals due to received sound levels ≥120 dB re 1 µPa (rms) for continuous noise, or ≥160 dB re 1 µPa (rms) for impulsive noise associated with BOEM/BSEE total oil and gas exploration authorizations under the First Incremental Step. Fractional takes rounded up.

Action (I = impulsive, N= nonimpulsive)[1]	Source level (dBRMS re 1 µPa @ 1 m)	Instances	duration per instance (days)	total duration	ensonified area radius (km)	Area ensonified per day (km2)	Densities				Estimated take			
							Humpback	Fin	Cook Inlet Beluga	WDPS Steller Sea Lion	Humpback take	Fin take	Beluga take	WDPS SSL take
Seismic surveys[2] (I)	238	2	90	180	9.5	784	0.00251	0.000343	0.00106	0.0085	354.2112	48.40416	149.5872	1199.52
Vertical Seismic Profiling (I)[3]	228	10	1	10	9.5	458	0.00251	0.000343	0.00106	0.0085	11.4958	1.57094	4.8548	38.93
Geotechnical (I)[4]	176	5	2	10	0.34	0.363168111	0.00251	0.000343	0.00106	0.0085	0.00911552	0.001245667	0.003849582	0.030869289
Geohazard (I)[5]	230	5	2	10	9.5	283.528737	0.00251	0.000343	0.00106	0.0085	7.116571298	0.972503568	3.005404612	24.09994264
Drill ship Anchor handling (N)[6]	195	20	1	20	14	615.7521601	0.00251	0.000343	0.00106	0.0085	30.91075844	4.224059818	13.05394579	104.6778672
Drill ship thrusters (N)[7]	188	10	2	20	34	3631.681108	0.00251	0.000343	0.00106	0.0085	182.3103916	24.9133324	76.99163948	617.3857883
Drill ship drilling[7](N)	176	10	60	600	5.4	91.60884178	0.00251	0.000343	0.00106	0.0085	137.9629157	18.85309964	58.26322337	467.2050931
Total											724.0167526	98.93934109	305.7600628	2451.849561

[1]For impulsive noise sources, the area ensonified extends outward to the 160 dB isopleth. For non-impulsive noises, the area ensonified extends outward to the 120 dB isopleth.
[2]area ensonified per day assumes a 9 km x 9 km patch surveyed per day and a 9.5 km radius ensonified zone around that patch.
[3]Vertical seismic profiling assumes acoustic impacts no greater than recent Cook Inlet 3D seismic surveys (9.5 km radius ensonified zone) and a 2400 x 2400 m area.
[4]Assumes geotechnical and drilling are equal in acoustic output.
[5]Geohazard source level from BOEM 2016a.
[6]Area ensonified due to anchor handling obtained from NMFS (2016g).
[7]Sound source level from BOEM 2016a.

Critical Habitat Exposure to Major Noise Sources

In considering the exposure of major noise sources upon Cook Inlet beluga whale and Steller sea lion critical habitat, we must consider the effects of that noise on their prey species. There are two sensory systems that enable fish to monitor the vibration based information of their surroundings. The two sensory systems, the inner ear and the lateral line, constitute the acoustico-lateralis system. Although the hearing sensitivities of very few fish species have been studied to date, Popper and Carlson (1998) and the Department of the Navy (2001) found that fish generally perceive underwater sounds in the frequency range of 50–2,000 Hz, with peak sensitivities below 800 Hz.

Fish are sensitive to underwater impulsive sounds due to swim bladder resonance. Such sounds include those indicated in Table 18 and Table 19. As the pressure wave passes through a fish, the swim bladder is rapidly squeezed as the high pressure wave, and then the under pressure component of the wave, passes through the fish. The swim bladder may repeatedly expand and contract at the high sound pressure levels, creating pressure on the internal organs surrounding the swim bladder. Literature relating to the impacts of sound on marine fish species can be divided into the following categories: (1) Pathological effects; (2) physiological effects; and (3) behavioral effects. Pathological effects include lethal and sub-lethal physical damage to fish; physiological effects include primary and secondary stress responses; and behavioral effects include changes in exhibited behaviors of fish.

Behavioral changes might be a direct reaction to a detected sound or a result of the anthropogenic sound masking natural sounds that the fish normally detect and to which they respond. The three types of effects are often interrelated in complex ways. For example, some physiological and behavioral effects could potentially lead to the ultimate pathological effect of mortality. Hastings and Popper (2005) reviewed what is known about the effects of sound on fishes and identified studies needed to address areas of uncertainty relative to measurement of sound and the responses of fishes.

The level of sound at which a fish will react or alter its behavior is usually well above the detection level. Fish have been found to react to sounds when the sound level increased to about 20 dB above the detection level of 120 dB (Ona 1988); however, the response threshold can depend on the time of year and the fish's physiological condition (Engas et al. 1993).

Information on effects of sound upon prey items of Cook Inlet beluga whales, western DPS Steller sea lions, and humpback and fin whales is limited. No seismic survey-related acoustic impact studies have been conducted to date on the fish species most likely present during the summer months in Cook Inlet, but studies have been conducted on Atlantic cod (*Gadus morhua*) and sardine (*Clupea* sp.). Davis et al. (1998) cited various studies and found no effects to Atlantic cod eggs, larvae, and fry when received levels were 222 dB; however, effects were found upon larval fish when they were within about 5.0 m (16 ft) from the sound source (air guns with displacement volumes between 49,661 and 65,548 cm^3 [3,000 and 4,000 in^3]). Similarly, effects to sardine were greatest on eggs and two-day-old larvae, but these effects were greatest at 0.5 ft (1.6 ft), and were limited to within 5.0 m (16 ft) of the sound source. Greenlaw et al. (1988) found no evidence of gross histological damage to eggs and larvae of northern anchovy

(*Engraulis mordax*) exposed to seismic air guns, and concluded that noticeable effects would result only from multiple, close exposures. This suggests that acoustic injury to prey results from particle motion (which is highly localized, on the order of meters) rather than from sound waves.

McCauley et al. (2017) conclude that marine seismic surveys can have significant negative impacts upon zooplankton populations, upon which some prey species of beluga, fin and humpback whale and Steller sea lion rely, and upon which fin and humpback rely directly.

6.1.3.2 Exposure to Vessel Noise

Mitigation Measures to Minimize the Likelihood of Exposure to Vessel Noise

As discussed in Section 2.6, the following mitigation measures will be required through BOEM and BSEE's permitting process to avoid or minimize exposure of marine mammals to vessel noise:

1. PSOs are required on seismic source vessels, drilling vessels, and other vessels engaged in activities that may result in an incidental take through acoustic exposures;

2. Vessels must maintain a vigilant watch for listed whales and pinnipeds, avoid multiple changes in direction, and reduce speed when within 274 m of whales or pinnipeds; and

3. Vessels will not approach within 100 m of marine mammals

Approach to Estimating Take due to Vessel Noise

General vessel transit includes: geophysical and geotechnical survey transits, deliveries, tugs moving drill rigs, support vessels, and OSRVs. These acoustic impacts will result from moving sources, and for individual marine mammals that are exposed to noise from transiting vessels, the effects from each exposure will be temporary in duration, on the order of minutes. For species such as humpback and fin whales that prey upon food items that are not tied to a particular location in the way that salmon are seasonally tied to stream channels and stream mouths, effects of transient and temporary noise are expected to result in low levels of exposure and exposure that the animals can likely avoid without foregoing highly valuable foraging opportunities.

During 2001, underwater sound measurements from vessels in transit were recorded in Cook Inlet. The highest source level reported was 150 dB re 1 μPa rms at 1 m (Blackwell and Green 2002). The 120 dB isopleth was calculated using the practical spreading loss model (15 Log R), resulting in a radius of approximately 100 meters. Jacobs Engineering (2017) report that tugs towing drill rigs will have source levels of 170 dB re 1 μPa rms at 1 m, resulting in a radius of about 2,200 m to the 120 dB isopleth.

Project-related activities at port facilities (i.e., staging operations, resupply, etc.) will also result in noise, and are expected to be similar to noise produced at the Port of Anchorage, where large ships dock to offload and take on large amounts of cargo. Background sound levels including vessel noise measured at the POA in 2007 recorded highly variable sound pressure levels ranging from 105 to 135 dB re 1μPa rms (POA 2017).

Results of Vessel Noise Exposure

Listed cetaceans and pinnipeds and critical habitat have the potential to overlap with vessel noise associated with the proposed oil and gas exploration activities during the first incremental step. We will discuss potential responses of listed species to vessel noise in Section 6.1.4.4.

Because the ensonified zone around most vessels (excluding drill ships and tugs moving rigs) is only anticipated to be 100 m, and these vessels will be able to change course, slow down, or stop in order to avoid marine mammals, we can assume substantial effectiveness of mitigation measures to avoid high received levels of noise. While the ensonified zones of tugs are substantially larger (~ 2,200 m while towing jack-up rigs), there are only anticipated to be 13 tug-assisted rig movement operations with a duration of less than one day per excursion.

Fish are important components of critical habitat for both Cook Inlet beluga whales and Steller sea lions. Much of the machinery necessary to drive and operate a ship produces vibration within the frequency range of 10 Hz to 1.5 kHz, with the consequence of radiation in the form of pressure waves from the hull (Mitson and Knudsen, 2003). In addition to broadband propeller noise, there is a phenomenon known as "singing," when a discrete tone is produced by the propeller, usually due to physical excitation of the trailing edges of the blades. This can result in very high tone levels within the frequency range of fish hearing. The overall noise of a vessel may emanate from many machinery sources and expose primary prey species. Pumps in particular are often considerable producers of noise from vibration and, at higher frequencies, from turbulent flow. Sharp angles and high flow rates in pipework also can cause cavitation, and even small items of machinery might produce quite high levels of noise.

In addition, noise at project-related port facilities could affect passage of Cook Inlet beluga whales within their critical habitat (Cook Inlet beluga whale critical habitat PBF 4 of unrestricted passage within or between the critical habitat areas (50 CFR §226.220(c)(4)) or cause temporary abandonment of critical habitat areas used by Cook Inlet beluga whales (Cook Inlet beluga whale critical habitat PBF 5 of waters with in-water noise below levels resulting in the abandonment of critical habitat areas (50 CFR §226.220(c)(5)).

6.1.3.3 Exposure to Aircraft Noise

Mitigation Measures to Minimize the Likelihood of Exposure to Aircraft

As discussed in Section 2.5, the following mitigation measures will be required through BOEM and BSEE's permitting process to avoid or minimize exposure of marine mammals to aircraft noise:

1. Aircraft shall not fly below 1,500 ft (457 m) altitude while within 500 lateral yards (457 m) of marine mammals while over land or sea (except for take-off, landing, emergency situations, and inclement weather). In addition, aircraft will avoid the Steller Sea Lion critical habitat air zones by remaining 3,000 feet above designated rookeries and major haulouts.

2. When weather conditions do not allow a 1,500 ft (457 m) flying altitude, such as during storms or when cloud cover is low, aircraft may be operated below 1,500 ft (457 m), but the operator should avoid known marine mammal concentration areas and take precautions to avoid flying directly over or within 500 yards (457 m) of marine mammals.

3. Helicopters may not hover or circle above marine mammals.

4. Support aircraft must avoid extended flights over the coastline to minimize effects on marine mammals in nearshore waters or the coastline.

Approach to Estimating Take due to Aircraft Noise

Exploration surveys, drilling operations, and oil spill drill efforts may be supported by fixed-wing and rotary aircraft. Little aircraft traffic is anticipated in association with marine surveys during the first incremental step. During exploratory drilling, up to 21 round-trip flights (primarily using helicopters) could occur each week per drilling rig (maximum of two drilling rigs) (BOEM 2017b).

Drilling operations are anticipated to occur for up to a total of 180 days in a year (30-60 days/well x 3 wells maximum in any given year) with up to 21 round-trip flights per week for up to 8.6 weeks per well for 10 wells resulting in 1,800 round trips for the first incremental step.

Oil spill drills are another source of aircraft traffic during the first incremental step. BOEM assumes 1-3 exercises per years, each lasting no more than one day. The number and type of aircraft would very dependent on the exercise. It is assumed aircraft would be staged out of shore bases in Kenai, Nikiski, Homer, or Anchorage (BOEM 2017b).

Fixed-wing aerial surveys flown by NMFS are typically conducted with aircraft flying at 1,500 ft (AGL), unless safety due to weather or other factors becomes an issue (see Section 2.5). However, Greene and Moore (1995) determined that fixed wing aircraft typically used in offshore activities were capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 162 dB re 1 μPa m at the source.

Greene and Moore (1995) explained helicopters commonly used in offshore activities radiate more sound forward than backwards, and are capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 151 dB re 1 μPa m at the source. By radiating more noise forward of the helicopter, noise levels will be audible at greater distances ahead of the aircraft than to the rear.

Low-flying aircraft produce sounds that marine mammals can hear when they occur at or near the ocean’s surface. Transference of noise from aircraft is generally limited to a 13 degree-radius cone beneath the aircraft, although this cone of sound penetration can vary somewhat as water surface conditions change (Richardson et al. 1995a). Helicopters generally tend to produce sounds that can be heard at or below the ocean's surface more than fixed-wing aircraft of similar size, and larger aircraft tend to be louder than smaller aircraft. Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Aircraft noise is typically present for shorter periods of time and moves at a greater speed due to the higher travel speed of aircraft, as opposed to vessel noise (Luksenberg and Parsons 2009). Sounds from aircraft would not have physical effects on marine mammals but represent acoustic stimuli (primarily low-frequency sounds from engines and rotors) that have been reported to affect the behavior of some marine mammals.

Belugas reacted to aircraft flying at 150-200 meters away by diving for longer periods, reducing surfacing time and sometimes swimming away (Richardson et al. 1995a). They did not response to aircraft at 500 meters away.

There are studies of the responses of marine animals to air traffic, and the few that are available have produced mixed results. The nature of sounds produced by aircraft above the surface of the water does not pose a direct threat to the hearing of marine mammals that are in the water; however, minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations (Richardson et al. 1985a, Richardson et al. 1985b, Patenaude et al. 2002). Richardson et al. (1995a) reported that there is no evidence that single or occasional aircraft flying above large whales cause long-term displacement of these mammals.

Sea lion pups on land are vulnerable to trampling if adults are panicked by low flying aircraft. Calking (1979) reported that the reaction of Steller sea lions to aircraft is variable. Withrow (1985) witnessed 1,000 + animals stampede off a beach in response to a Bell 205 helicopter greater than 1.6 km away (Richardson et al. 1995a). In recognition of this vulnerability, Steller sea lion critical habitat has been defined to include air zones 3,000 feet above the terrestrial zones of designated haulouts and rookeries.

In a review of aircraft noise effects on marine mammals, Luksenburg and Parsons (2009) determined that the sensitivity of whales and dolphins to aircraft noise may depend on the animals' behavioral state at the time of exposure (e.g. resting, socializing, foraging, or traveling) as well as the altitude and lateral distance of the aircraft to the animals. While resting animals seemed to be disturbed the most, low flying aircraft with close lateral distances over shallow water elicited stronger disturbance responses than higher flying aircraft with greater lateral distances over deeper water (Luksenberg and Parsons 2009).

Aircraft associated with this action are not expected to operate in the vicinity of Steller sea lion haulouts or rookeries, for which a minimum 3,000 ft (915 m) buffer should be maintained to avoid critical habitat and possibly causing animals to trample one another as they flee. Considering that the proposed mitigation would require aircraft not to operate within 1,500 ft (457 m) of marine mammals or below 1,500 ft (457 m) altitude, we would not expect marine mammals to be adversely affect by the noise or presence of aircraft. We conclude that if any responses of marine mammals associated with aircraft were to occur, they are likely to be short-lived and therefore are not expected to cause more than a temporary and/or minor effect on listed species.

6.1.3.4 Exposure to Vessel Strike

Mitigation Measures to Minimize the Likelihood of Exposure to Vessel Strike

As discussed in Section 2.5, the following mitigation measures will be required through BOEM and BSEE's permitting process to avoid or minimize exposure of marine mammals to vessel strike:

1. PSOs will be used to monitor for, and take steps to minimize occurrence of, marine mammals within Level A harm and Level B harassment zones for all operations;

2. Vessels in transit shall be operated at speeds necessary to ensure no physical contact with whales occurs;
- **a)** Vessels will avoid multiple changes in direction and reduce speed when within 274 m (300 yards) of marine mammals; and
- **b)** Vessels will not approach within 100 m of marine mammals.

Approach to Estimating Take due to Vessel Strike

As discussed in the *Proposed Action* section of this opinion, the activities BOEM and BSEE propose to authorize during the first incremental step would increase the number of vessels transiting the area. Additional vessel traffic could increase the risk of exposure between vessels and marine mammals.

Assumptions of increased vessel traffic related to the proposed action are as follows:

- All vessels associated with the first incremental step would operate out of existing shore bases.
- Vessel traffic may occur year-round because the proposed lease sale area remains relatively ice free in the winter months due to the strong currents.
- The maximum number of vessels associated with marine seismic survey activities is anticipated to be 8 vessels (6 survey and 2 support vessels) used for OBC seismic surveys. A support vessel may make up to 2 round-trips per week.[16]
- The maximum number of vessels associated with geotechnical activities is one vessel.
- The maximum number of vessels associated with geohazard high-resolution activities is two vessels.
- The maximum number of non-tug vessels associated with exploratory drilling activities from a jack-up rig would be three vessels.[17] Support vessels may make up to 104 round-

[16] BOEM anticipates support vessels may make 1-2 round trips per week. Marine seismic operations are anticipated to take up to 90 days, which equals approximately 26 round trips per support vessel per seismic operation.

[17] BOEM anticipates one jack-up rig or a drillship plus (2) support vessels for a total of three vessels per drilling operation.

trips per drilling year,[18] plus 13 round trips by tugs used to tow jack-up rigs.

- Two tugs will be used to move each jack-up rig.
- One drilling vessel and two support vessels will be associated with each well.

Based on the proposed action, the anticipated number of vessels that would be associated with authorized activities during the first incremental step would be 57 vessels[19] spending 2,170 vessel days on the water (Table 20). Should drillships be used, the total may be marginally less.

Table 20. Anticipated vessel use during the first incremental step

Action	Max # survey vessels	# trips (sourc e vessel)	Duration of trip (source vessel) in days	Source vessel days	Max # support vessels	# trips (suppor t vessel)	Duration of trip (support vessel) in days	Support vessel days
Seismic surveys	6	2	60	720	3	2	17	102
Verical seismic profiling	1	10	1	10	0	0	1	0
Geotechnical	1	5	60	300	0	0	0	0
Geohazard	2	5	36	360	0	0	0	0
Tugs moving rig	2	13	1	26	0	0	0	0
Drilling	1	10	60	600	2	26	1	52
Total vessel days				2016				154

Evidence suggests that a greater rate of mortality and serious injury to marine mammals correlates with greater vessel speed at the time of a ship strike (Laist et al. 2001, Vanderlaan and Taggart 2007 as cited in (Aerts and Richardson 2008)). Vessels transiting at speeds >10 knots present the greatest potential hazard of collisions (Jensen and Silber 2004, Silber et al. 2009). Vanderlann and Taggart (2007) demonstrated that the greatest rate of change in the probability of a lethal injury to a large whale occurs between vessel speeds of 8.6 and 15 knots. Most lethal and severe injuries resulting from ship strikes have occurred from vessels travelling at 14 knots or greater (Laist et al. 2001).

While most seismic survey operations occur at relatively low speeds (1-5 knots), large vessels are capable of transiting at up to 20 knots and operate in periods of darkness and poor visibility (BOEM 2017b). In addition, large vessels when traveling cannot perform abrupt turns and cannot slow speeds over short distances to react to encounters with marine mammals. All of these factors increase the risk of collisions with marine mammals. However, BOEM/BSEE propose to include vessel strike mitigation measures as described in Section 2.5 and highlighted

[18] BOEM anticipates support vessels may make 1-2 round-trips per week. Exploratory drilling operations are anticipated to take up to 180 days, which equals approximately 52 round-trips per support vessel. BOEM anticipates that drilling operations may have as many as 2 offshore supply vessels, so we anticipate a total of 104 round-trips per drilling season.

[19] This is based on BOEM's scenario that two marine seismic surveys (18 vessels), five geohazard surveys (10 vessels), five geotechnical surveys (5 vessels), and 2 drilling operations over four years (24 vessels) may occur during the First Incremental Step, totaling 57 vessels.

above. Operators are also required to abide by NMFS's standard mitigation measures through MMPA authorization. PSOs on survey ships to alert vessel operators to the presence of marine animals are also expected to help vessels avoid marine mammal strikes.

Exposure to Listed Species

Vessels will transit year-round, and beluga, fin, and humpback whales, and Steller sea lions are known to transit and feed in the action area year-round. However, available information indicates that vessel strikes of whales in the region are low and there is no indication that strikes will become a major source of injury or mortality in the action area.

NMFS researchers have witnessed avoidance and overt behavioral reactions by Cook Inlet belugas when approached by small vessels (e.g., Lerczak et al. 2000). Although a beluga ship strike is rarely reported, a dead beluga whale washed ashore in Cook Inlet in 2007 with "wide blunt trauma along the right side of the thorax" (NMFS 2008b), suggesting a ship strike was the cause of the injury. In October 2012, a necropsy of another Cook Inlet beluga carcass indicated the most likely cause of death was "blunt trauma such as would occur with a strike with the hull of the boat" (NMFS AKR, unpub. data). Scarring consistent with propeller injuries has also been documented among CI belugas (Burek 1999; LGL 2009; McGuire et al. 2011). Ship strikes with large vessels are not likely to occur or significantly affect listed species because large ships in the action area travel at slower speeds and in a direct route. Smaller boats that travel at high speed and change direction often present a greater threat than larger, slower vessels that move in straight lines (NMFS 2009).

Around the world, fin whales are killed and injured in collisions with vessels more frequently than any other whale (Laist et al. 2001, Jensen and Silber 2004, Douglas et al. 2008). Differences in frequency of injury types among species may be related to morphology. The long, sleek, fin whale tends to be caught on the bows of ships and carried into port where they are likely found and recorded in stranding databases (Laist et al. 2001). There have been 108 reports of whale-vessel collisions in Alaska waters between 1978 and 2011. Of these, 3 involved fin whale, but none were in Cook Inlet (Neilson et al. 2012). However, during 2015, one dead fin whale came into the Port of Anchorage on the bulbous bow of a ship traveling from Seattle. However, it was unknown where the initial strike occurred (NMFS Alaska Regional Office Stranding Database accessed May 2017). Even if vessel-related deaths of fin whales in the waters outside of the action area, where strikes of fin whales have been known to occur, were several times greater than observed levels, it would still be a small fraction of the total fin whale population (Laist et al. 2001).

Some of the unique feeding habits of fin whales may also put them at a higher risk of collision with vessels than other baleen whales. Fin whales lunge feed instead of skim feeding. These lunges are quick movements which may put them in the path of an oncoming vessel, and give the captain of a vessel little time to react. In addition, despite their large body size, fin whales appear to be limited to short dive durations (Goldbogen et al. 2007), which may make them more susceptible to ship strikes when they are near the surface. Based on ship-strike records, immature fin whales appear to be particularly susceptible to strike (Douglas et al. 2008).

The number of humpback whales killed worldwide by ship strikes is exceeded only by fin whales (Jensen and Silber 2004). On the Pacific coast, a humpback whale is killed about every other year by ship strikes (Barlow et al. 1997). There were 108 reports of whale-vessel collisions in Alaska waters between 1978 and 2011. Of these, 93 involved humpback whales (Neilson et al. 2012). During 2001, one humpback whale came into Port of Anchorage on the bulbous bow of a ship traveling from Seattle. However, it was unclear where the initial strike occurred (NMFS Alaska Regional Office Stranding Database accessed May 2017). Between 2008 and 2012 the mean minimum annual human-caused mortality and serious injury rate for humpback whales based on vessel collisions in Alaska was 0.45, as reported in the NMFS Alaska Regional Office stranding database (Allen and Angliss 2015). However, even if vessel-related deaths of humpback whales in the waters outside of the action area, where strikes of humpback whales have been known to occur, were several times greater than observed levels, it would still be a small fraction of the total humpback whale population (Laist et al. 2001).

In 2002 near Homer, a Steller sea lion was found with two separate head wounds consistent with blunt trauma, with suspected vessel strike as the cause of the trauma (NMFS Alaska Regional Office Stranding Database accessed May 2017). There are no other reported vessel collisions or prop strikes of Steller sea lions in Cook Inlet.

Vessels would have a transitory presence in any specific location. NMFS is not able to quantify existing traffic conditions across the entire action area to provide context for the addition of 57 vessels and 2,470 vessel days associated with the proposed action. However, the rarity of collisions involving vessels and listed marine mammals in Cook Inlet, despite decades of spatial and temporal overlap, suggests that the probability of collision is low.

Based on the small number of vessels associated with the proposed action, the small number of activities being authorized per year by BOEM and BSEE, the limited number of sightings of fin and humpback whales in action area, the slow vessel speeds while towing the drill rig or conducting seismic surveys, mitigation measures to minimize exposure to vessel activities, and the rarity of collisions in Cook Inlet despite decades of spatial and temporal overlap between vessels and marine mammals, we conclude that the probability of a BOEM/BSEE-authorized vessel striking a listed species in the action area is extremely unlikely to occur and therefore impacts from vessel strikes on listed species is likewise improbable.

6.1.3.5 Exposure to Seafloor Disturbance

Marine mammal species in Cook Inlet primarily exploit prey resources in the water column, although examination of beluga stomach contents have revealed the presence of some benthic fauna. Aspects of the proposed action have the potential to cause seafloor disturbance, turbidity, and discharge that may impact marine mammal benthic prey species.

Seafloor disturbance can occur from sediment sampling, placement and removal of equipment on the seafloor, and discharge of drilling waste during geotechnical surveys and exploratory drilling activities (see Section 2.3). Sampling includes gravity/piston coring, shallow coring, gravity or vibracores, rotary cores, grab sampling, and individual sampling events last three days or less. Seafloor disturbance and scour can also occur from bottom founded anchors associated with exploratory drilling operations. Based on expected water depths in the Lease Sale 244 area and recent exploration activities in the state waters of Cook Inlet, it is likely that a jack up rig will be employed for exploration drilling. Areas of seafloor will be disturbed by placement and removal of jack-up rigs and anchors (BOEM 2017b).

There is the potential for seafloor disturbance to impact Cook Inlet beluga PBF 1[20] due to temporary disturbance and resuspension of sediments in the water column, including areas within five miles of anadromous fish streams (ASRC 2014). Because Cook Inlet beluga, humpback, and fin whales and Steller sea lions are not benthic feeders, or feed on benthic fauna only rarely, we do not expect these animals will be exposed to disturbances to the benthic environment.

Geotechnical Surveys

Although the placement of OBNs may temporarily affect the seafloor habitat, effects are likely to be temporary and small in scale relative to the total benthic habitat in Cook Inlet; therefore, these activities will likely have minimal impact on marine mammal foraging and primary prey associated with PBFs of critical habitat.

BOEM anticipates that geotechnical surveys involving coring could impact a small portion of the seafloor. Several hundred cores may be collected; however, sampling in soft bottom areas will produce only minor and highly localized turbidity, which is expected to immediately dissipate when sampling ends (BOEM 2017b).

Bottom sampling activities would primarily take place in soft bottom areas as most bottom sampling equipment cannot penetrate hard bottom substrate. Piston and gravity cores are approximately 8-cm (3-in) diameter holes in the seafloor and, depending upon the firmness of the seafloor, the core or probe weight stand (30-45 cm [12-18 in] diameter footprint) may also impact the seafloor. Grab sampling is performed to identify the benthic fauna. Grab sampling penetrates from a few inches to a few feet below the seafloor and typically involves 30-40 grabs within an area of interest. A vibracore survey generally uses a 7 cm (2.8 in) diameter core barrel mounted on a 2 to 4 m^2 platform that can penetrate sediments between 6 -15 m (20-50 ft) below the seafloor. Fifteen to twenty five cores would be obtained in a 1 mi^2 (259 ha) area of interest.

BOEM anticipates that geotechnical surveys involving coring have the potential to impact a small amount of habitat. Each rotary bore hole would affect roughly 233m^3 of soil below the seabed (BOEM 2015b).

Although several hundred cores may be collected, sampling in soft bottom areas would produce only minor, localized turbidity, which is expected dissipate when sampling ends.

Exploratory Drilling

Based on expected water depths in the Lease Sale 244 area and recent exploration activities in the state waters of Cook Inlet, it is likely that a jack-up rig or an anchored drill ship will be

[20] **PBF1:** Intertidal and subtidal waters of Cook Inlet with depths <30 feet (MLLW) and within five miles of high and medium flow anadromous fish streams (50 CFR §226.220(c)(5)).

employed for exploration drilling operations (BOEM anticipates most drilling operations in Cook Inlet will take place from a jack-up rig). Drilling operations are expected to range between 30 and 90 days at different well sites and may occur from March through December.[21] BOEM/BSEE anticipate authorizing two drilling operations per year with a total of six wells drilled per year, and drilling operations must occur on the active lease blocks.

Exploratory drilling will disturb an area of the seafloor. The area of disturbance would vary based on the type of drill rig used, ocean currents, and other environmental factors, but in general includes disturbance from the mudline cellar (MLC), the anchoring system for the drilling unit (e.g., legs of the jack up rig or footprint of the drillship anchors), displacement of sediments, and discharge of drilling waste (BOEM 2017b).

It is estimated that each set-up of a jack-up rig disturbs a seafloor area of approximately 1 ha (2.5 ac) (BOEM 2017b). Assuming 10 exploration and delineation wells will be drilled with a jack-up rig, a total of approximately 10 ha (25 ac) of seafloor could be disturbed as a result of potential jack-up rig placement activities resulting from the first incremental step.

Anchoring causes physical compaction of the seafloor beneath the anchor, and when chains or lines move, they can disturb the bottom and resuspend sediment. A disturbed area on the seafloor called an “anchor sweep” forms by the swing arc of anchor lines scraping across the bottom within the range allowed by the anchoring system configuration (BOEM 2012) that would be required for anchored drillships. Anchored drillships disturb approximately 2 to 3 ha (5 to 7 ac) of seafloor at each wellsite, depending on the number of anchors and their mooring configurations (BOEM 2012). Assuming 10 wells are drilled with an anchored drillship, a total of 20 to 30 ha (50 to 75 ac) of seafloor could be disturbed as a result of anchoring activities resulting from the First Incremental Step. The total area of seafloor disturbance from drilling of exploration or delineation wells will depend on the number of wells drilled from jack-up platforms as opposed to anchored drillships (BOEM 2016a).

Once the drilling units end operation, the anchors may be retrieved or left on site for wet storage. Over time the anchor scars will be filled through natural movement of sediment. The duration of the scars depends upon the energy of the system, water depth, ice scour, and sediment type. Scars typically do not form or persist in sandy mud or sand sediments but may last for nine years in hard clays (Centaur Associates Inc. 1984). The energy regime, plus possible effects of ice gouge in Cook Inlet, suggest that anchor scars would be refilled rather quickly.

No appreciable adverse impacts on benthic populations would be expected due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations. Any mortalities or impacts that might occur as a result of the proposed action is immaterial compared to the naturally occurring high reproductive and mortality rates of benthic organisms (BOEM 2015a). In addition, disturbed areas, depending on substrate types, community composition, and ocean current speed and direction, would begin the process of recolonization after deposition has completed following the benthic disturbance (Conlan and Kvitek 2005, BOEM 2015a). Amphipods, copepods, shrimp, nematodes, and polychaetes are among the first

[21] Drilling is not allowed on lease blocks within Cook Inlet beluga critical habitat between April 2 and October 31.

to recolonize, taking generally less than a year for establishment in new locations (Trannum et al. 2011).

Only localized turbidity is expected to occur as a result of the proposed bottom sampling activities. This turbidity is expected to dissipate rapidly in the inlet's strong tidal currents. Furthermore, in the highly turbid waters of Cook Inlet, increases in turbidity would be nearly imperceptible at the onset. Seafloor disturbance from anchor handling activities is anticipated to fill in through natural movement of sediment over time. Disturbance associated with excavation or exploration/delineation wells is anticipated to temporarily impact a small area of habitat which would soon be re-colonized by benthic organisms. Based on the above, we would not expect adverse effects to listed species from bottom sampling activities and would consider this stressor to be minor or minimal overall.

6.1.3.6 Exposure to Trash and Debris

Operations under the proposed action generate trash comprised of paper, plastic, wood, glass, and metal mostly from galley and offshore food service operations. A substantial amount of waste products could be generated from seismic and drilling activities over the duration of the proposed action. The possibility exists that trash and debris could be released into the marine environment.

Entanglement in marine debris is a threat to marine mammals worldwide. A 2014 global study found that ingestion of debris has been documented in 56% of cetacean species, with rates of ingestion as high as 31% in some populations (Baulch and Perry 2014). In Alaska, many species of cetaceans and pinnipeds are known to become entangled in or ingest marine debris. Manufactured packing bands are a particular problem for pinnipeds and should always be cut before disposal to prevent neck entanglements.

All survey vessels performing work within U.S. jurisdictional waters are expected to comply with federal regulations that implement the International Convention for the Prevention of Pollution from Ships (MARPOL) as amended by the 1978 Protocol (MARPOL 73/78). Within MARPOL Annex V, Regulations for the Control of Pollution by Garbage from Ships, as implemented by 33 CFR Part 151, are requirements designed to protect the marine environment from various types of garbage generated on board vessels. These requirements include: a prohibition on the deliberate discharge of containers and other similar materials (i.e., trash and debris) into the marine environment unless it is passed through a comminutor that breaks up solids and can pass through a 25-mm mesh screen; a prohibition on the discharge of plastic regardless of size; markings on equipment, tools and containers (especially drums), and other material as well as recording and reporting of items lost overboard; and precautions for handling and disposing of small items and packaging materials.

In addition to MARPOL requirements, all vessel operators, employees, and contractors actively engaged in exploration surveys or drilling operations should receive instruction on marine trash and debris elimination. Although BOEM will not require operators, employees, and contractors to undergo formal training or to post placards, the operator will be required to ensure that its employees and contractors are made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment.

Lessees are expected to exercise special caution when handling and disposing of small items and packaging materials, particularly those made of non-biodegradable closed loops, that can be lost in the marine environment and present a risk of entanglement. Increasing worker awareness of the problem and emphasizing their responsibilities will help reduce litter and control the unintended loss of such items.

Because operators must comply with Federal regulations and BOEM's trash and debris guidance, the amount of trash and debris occurring within the action area is expected to be minimal and distributed over a wide area resulting in an undetectable effect on the marine environment. As such we do not expect exposure of listed species to trash and debris. Absent requirements to cut all closed loops prior disposal, such items remain an unquantifiable source of potential take.

6.1.3.7 Exposure to Non-Seismic Geohazard Surveys

Non-airgun geohazard acoustic sources include single and multibeam echosounders, sub-bottom profilers, side scan sonars, and HiPaP positioning systems. These sources tend to be smaller and emit sounds at higher frequencies than airguns. The source levels of these devices range from 195 dB re 1 μPa at 1 m to 220 dB re 1 μPa at 1 m and have frequency ranges from 1 kHz to 900 kHz (BOEM 2017b).

Mitigation Measures to Minimize the Likelihood of Exposure to Other Impulsive Noise Sources

Mitigation measures are described in detail in Section 2.5. The following mitigation measure will be required through BOEM and BSEE's permitting process to avoid or minimize exposure of marine mammals to geohazard surveys:

1. PSOs are required on all vessels engaged in activities that may result incidental take through acoustic exposure, which will help implement steps to minimize the occurrence of marine mammals within Level A harm and Level B harassment zones.

Approach to Estimating Exposures to Other Impulsive Noise Sources

In addition to the major noise sources described in section 6.1.3.1, we also analyzed other impulsive non-airgun noise sources associated with geohazard surveys including: single and multibeam echosounders, subbottom profilers, side-scan sonar, and HiPaP positioning systems. Section 2.3.4 describes each of these sound sources, with source levels and frequency ranges, in more detail. We relied on the measured radii for the non-airgun geohazard survey sources from Statoil's 2011 geohazard survey in the Chukchi Sea (Warner and McCrodan 2011). We used these radii to estimate the ensonified area for each source (Table 21).

Table 21. Ensonified area estimates associated with various received sound levels for non-airgun geohazard survey sources (ensonified area provided in km^2) (Warner and McCrodan 2011, Austin et al. 2015).

Sound Source		190 dB	180 dB	160 dB	120 dB
Subbottom profiler	Ensonified	--	--	.003	.636

	Area (km^2)				
Side scan sonar	Ensonified Area (km^2)	0.001	0.008	0.166	81.671
Single beam echosounder	Ensonified Area (km^2)	--	--	0.005	3.140
Multibeam echosounder	Ensonified Area (km^2)	--	--	--	0.342
HiPap (22/23 kHz)	Ensonified Area (km^2)	--	--	0.005	3.140

Results of Exposure Analysis from Other Impulsive Noise Sources

Since the Table 21 values are projections for future BOEM authorizations, the specific models of each device and the exact frequency and source levels are unknown at this point, but we anticipate that underwater sound propagation would drop to 160 dB within 40 m (or less) based on source measurements during Statoil's 2011 geohazard survey in the Chukchi Sea (Warner and McCrodan 2011). Marine mammals are unlikely to be subjected to repeated pings because of the narrow fore-aft width of the beam and will receive only limited amounts of energy because of the short pings. The beam is narrowest closest to the source, further reducing the likelihood of exposure to marine mammals.

Based on the small ensonified area estimates (Table 18 and Table 19), no exposures are anticipated to occur at received levels ≥160 dB.

Given the directionality, short pulse duration, and small beam widths for these acoustic sources, only a few exposures at low received levels (below 160 dB) are anticipated for listed species. If exposed, whales and sea lions would not be anticipated to be in the direct sound field for more than one to two pulses (NMFS 2013). Based on the information provided, most of the energy created by these potential sources is outside the estimated hearing range of baleen whales, and pinnipeds generally (Southall et al. 2007), and the energy that is within hearing range is high frequency; as such, it is only expected to be audible in very close proximity to the mobile source. We do not anticipate these sources to be operating in isolation, and expect co-occurrence with other acoustic sources including airguns. Many whales and sea lions would move away in response to the approaching airgun noise or the vessel noise before they would be in close enough range for there to be take due to the non-airgun related sources. In the case of whales and sea lions that do not avoid the approaching vessel and its various sound sources, mitigation measures that would be applied to minimize effects of seismic sources (see Section 2.5) would further reduce or eliminate any potential effect from non-airgun acoustic sources.

All of these factors significantly reduce the probability of beluga whales, fin whales, humpback whales, and Steller sea lions being exposed to sound fields associated with single and multibeam echosounders, sub-bottom profilers, side scan sonars, and HiPaP positioning sources to levels that would not be expected to have measureable effects on these listed species.[22]

6.1.3.8 Exposure to Authorized Discharges

Authorized discharges from OCS activities during the first incremental step would include drilling fluids and cuttings, deck drainage, sanitary and domestic waste, desalination unit brine, cooling water, bilge and ballast water, and other miscellaneous discharges. Most of these discharges would be rapidly diluted in receiving waters such that there would be very limited potential for effects on any listed marine mammals. Benthic impacts including burial and smothering are most likely to occur within a radius of approximately 500 m (1,640 ft) around each wellsite, affecting an area of 0.78 km^2 per wellsite. Discharges are regulated through NPDES permits, and listed species and designated critical habitats are not likely to be adversely impacted by exposure to pollutants, suspended solids, or bacteria-containing effluents discharged in compliance with permit requirements (BOEM 2017b). Additional consultation would be required for the issuance of a NPDES permit.

6.1.3.9 Exposure to Oil and Gas Spill

As previously mentioned in the *Environmental Baseline* section of this opinion, pollutants in discharges from OCS facilities are regulated through the NPDES permit, and marine mammals are not expected to be adversely impacted by exposure to pollutants discharged in compliance with the permit requirement (NMFS 2010c, EPA 2015b).

Oil spill response activities are not a component of the proposed action and have been previously consulted on by NMFS as part of the *Alaska Federal/State Preparedness Plan for Response to Oil & Hazardous Substance Discharges/Releases (Unified Plan)* consultation (AKR 2014-9361).

The remainder of this analysis will thus be focused on the probability of an unauthorized discharge of oil and gas, and the potential impacts associated with exposure of ESA-listed marine mammals under NMFS's authority to small, large, and VLOS events during exploration activities in the action area.

Mitigation Measures to Minimize the Likelihood of Exposure Oil and Gas Spill

At the lease sale stage, mitigation measures take the form of lease stipulations; post-lease activities may have mitigation measures imposed through conditions for approval of plans, permit conditions, or other mechanisms. As specific projects are proposed in this multi-stage oil and gas program, more precise information about the nature and extent of the activities – including the scale and location of the activities and a description of the particular technologies to be employed – will be considered and evaluated in additional ESA section 7 consultations and other analyses (such as NEPA) as appropriate. Additional mitigation measures and protections may be developed at any stage based on the specific details of the particular projects.

[22] Sounds that are not likely to have measurable effects on listed species relate to the size of the impact and should never reach the scale where take occurs. In this situation, exposures may occur to a few whales and pinnipeds at ≥120 dB, but at received levels far below what would be considered "take" for impulsive sounds (≥160 dB).

Regulations/Requirements
In light of the 2010 Deepwater Horizon explosion, loss of life, oil spill, and response, the federal government, along with industry, adopted new rules and safety measures related to oil-spill prevention, containment, and response.

BOEM and BSEE instituted regulatory reforms in response to many of the recommendations expressed in the various reports prepared following the Deepwater Horizon event, including both prescriptive and performance-based regulation and guidance, as well as OCS safety and environmental protection requirements. The reforms strengthen the requirements for all aspects of OCS operations. Ongoing reform and research endeavors of BSEE to improve workplace safety and to strengthen oil-spill prevention, planning, containment, and response are described in the 2012-2017 Programmatic EIS (BOEM 2012b).

NTL (Notice to Lessees) 2015-N01. Effective January 14, 2015, NTL No. 2015-N01 requires that blowout intervention information be submitted with future Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents (collectively referred to in this NTL as "plans"), if a plan includes a drilling activity. NTL No. 2015-N01 outlines the information required by regulation to be submitted with plans. Pursuant to 30 CFR §550.213(g), an EP must be accompanied by a blowout scenario description. 30 CFR §550.243(h) imposes the same requirement for a DPP and a DOCD. Pursuant to 30 CFR §550.219 and §550.250, all plans must also be accompanied by information regarding potential oil spills, including calculations of the worst case discharge scenario. BOEM adds information submitted pursuant to NTL 2015-N01 to its cumulative data library to comprehensively assess what changes may be needed to BOEM program-wide requirements and to inform its review of future activities under an EP, DPP, or a DOCD.

ITL (Information to Lessees) No. 5 – Sensitive Areas to be Considered in Oil Spill Response Plans. This ITL lists certain areas in Cook Inlet that are especially valuable for their concentrations of marine birds, marine mammals, fish, other biological resources or cultural resources, and for their importance to subsistence harvest activities. Lessees are advised to consider these areas when developing their OSRPs.

Behavior and Fate of Crude Oil

Effects of oil are based on its chemical composition. Likewise, the composition of crude oil determines its behavior in the marine environment (Geraci and St. Aubin 1990b). Weathering (spreading, evaporating, dispersing, emulsifying, degrading, oxidizing, dissolution: Figure 21) and aging processes can alter the chemical and physical characteristics of crude oil. The environment in which a spill occurs, such as the water surface or subsurface, spring ice overflow, summer open-water, winter under ice, winter on ice, or winter broken ice, will affect how the spill behaves. In ice-covered waters many of the same weathering processes occur; however, the sea ice and cold temperatures change the rates and relative importance of these processes (Payne et al. 1991, NRC 2014).

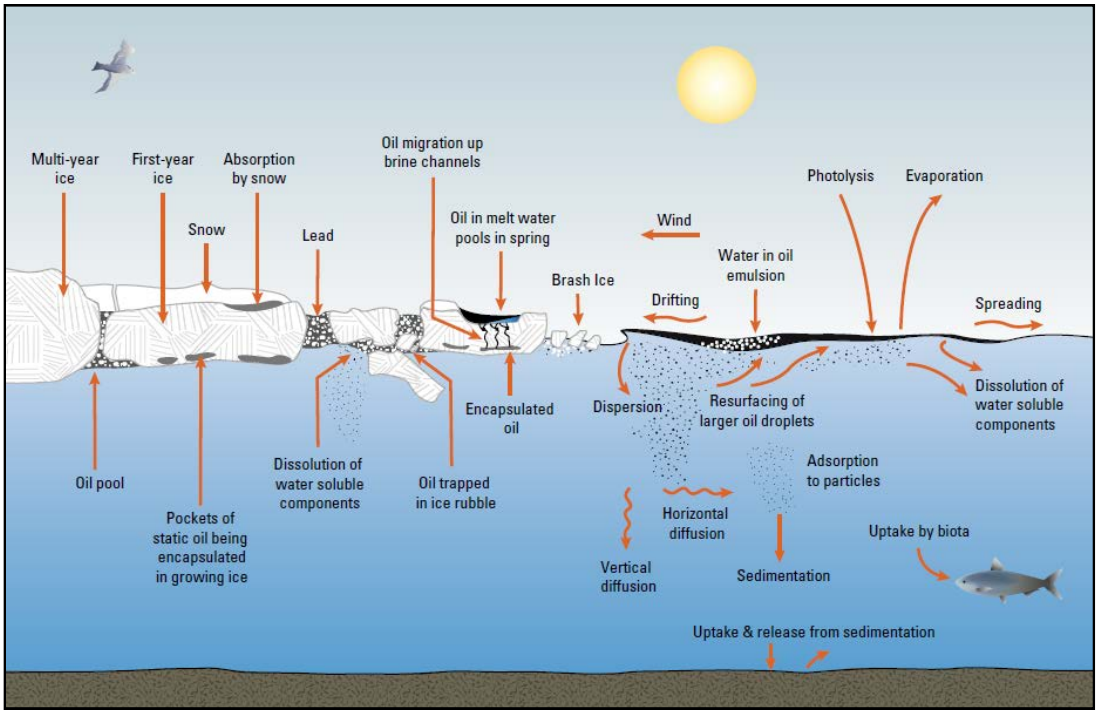


Figure 21. Diagram of some of the weathering processes that occur to oil spilled into the marine environment (NRC 2014).

Oil released at or near the surface will immediately begin to spread, or drift, horizontally in an elongated shape driven by wind and surface water currents (Elliott et al. 1986). If released below the water, oil will travel through the water column before it forms an oil slick at the surface. The rate of spreading is positively associated with increased temperature and wave action (Geraci and St. Aubin 1990b). Oil spills in the cooler waters are expected to spread less and remain thicker than in temperate waters due to increased viscosity of oil in colder temperatures (NRC 2014). The leading edge of the slick is typically thicker than the interior (Fannelop and Waldman 1972). The thicker oil tends to form patches that move downwind faster than the thinner part of the slick, eventually leaving it behind (Geraci and St. Aubin 1990b).

In increasing ice conditions (which may be present in middle to upper Cook Inlet) spilled oil would be bound up in the ice, pumped to the surface by wind/wave action, or encapsulated in pack ice. In spring, the unweathered oil would melt out of the ice at different rates and locations (NMFS 2015.

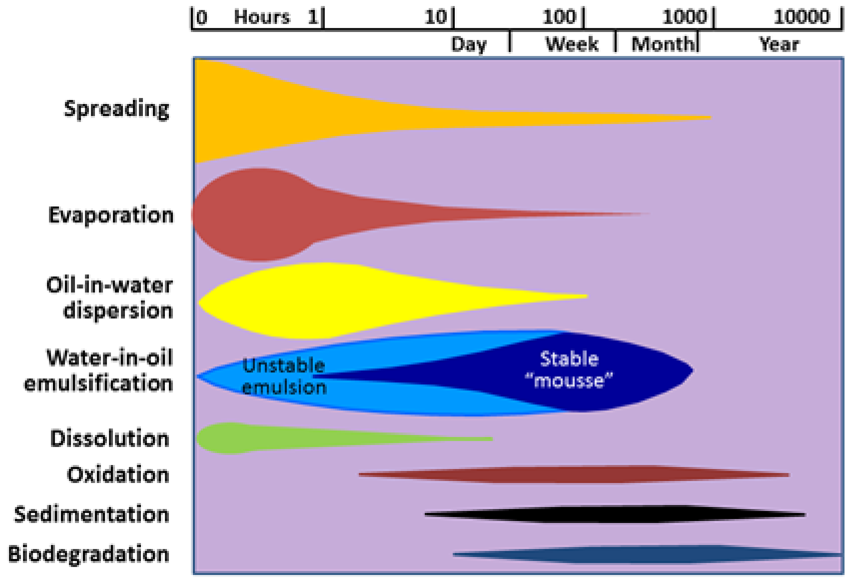


Figure 22. Schematic showing the relative importance of weathering processes of an oil slick over time (Brandvik et al. 2010). The width of the line shows the relative magnitude of the process in relation to other contemporary processes.

In the first few days following a spill, evaporation is the most significant weathering process, affecting the volume and chemical composition of oil (Geraci and St. Aubin 1990b) (Figure 22). The lighter, more volatile hydrocarbons evaporate most quickly, increasing the density and viscosity, and decreasing the toxicity and vapors of the oil (Mackay 1985). About 30-40% of spilled crude consists of volatile hydrocarbons that evaporate, with approximately 25% of the evaporation occurring in the first 24 hours (Fingas et al. 1979, NRC (National Research Council) 1985). Initial evaporation rate increases with increased wind speed, temperature, and sea state. Evaporation rates decrease when oil spills in broken ice conditions, and evaporation stops altogether if the oil is under or encapsulated in ice (Payne et al. 1987, Payne et al. 1991). In the spring, oil that has been trapped in ice will be released to the surface and evaporation will occur.

Approximately 2-5% of spilled crude oil is dissolved into the water column (Payne et al. 1987). Although this appears to be a small proportion of the crude oil, this dissolution process is significant because it brings the most toxic hydrocarbons into contact with marine organisms in a form that is biologically available to them (Geraci and St. Aubin 1990b). Once dissolved in water and then captured in ice, field studies showed that high air temperature led to more porous ice, thereby allowing the dissolved water-soluble components of crude oil to rapidly leak out, but under cold air temperatures and less porous ice, the water-soluble components were released more slowly and had potentially toxic concentrations (Faksness and Brandvik 2008).

Dispersion is the most significant weathering process in the breakdown of an oil slick already reduced by evaporation (Geraci and St. Aubin 1990b), and results in the transport of small oil particles into the water column (NRC (National Research Council) 1985). Increased wave action and water turbulence are directly associated with an increased rate of dispersion (Mackay 1985). Small oil droplets break away from the main oil slick and become dispersed in the water column. If the droplets become smaller than 0.1 mm in size they rise so slowly as to remain indefinitely dispersed in the water column (Payne and McNabb 1985). More viscous and/or weathered crude oil may adhere to porous ice floes, concentrating oil within areas of broken ice and limiting oil dispersion. However, the presence of a small amount of ice is thought to promote dispersion (Payne et al. 1987).

After weathering, some oils will accumulate and retain water droplets within the oil phase. This process is called emulsification, and the emulsified oil is typically referred to as 'mousse' (Mackay 1985). Mousse can form more quickly under certain conditions; with sufficient gas, turbulence, and mousse-forming precursors in the oils, oil spilled subsurface can form mousse by the time it reaches the surface (Payne 1982). The formation of mousse slows the subsequent weathering of oil by inhibiting evaporation, dissolution, and degradation (Geraci and St. Aubin 1990b). The presence of ice and turbulence increases emulsification (Payne et al. 1987).

Most oil droplets suspended in the water column will eventually be degraded by bacteria in the water column, or deposited to the seafloor. This deposition, or sedimentation, depends on many factors: suspended load in the water column, water depth, turbulence, oil density, and processing by zooplankton. Weathered oil can become heavier than seawater and sink (Boehm 1987). This process is enhanced when the density of water is lowered by input of fresh water from runoff or melting ice.

Biodegradation, or natural degradation by marine fungi and bacteria (microbial organisms), begins 1-2 days following a spill and continues as long as hydrocarbons remain in the water and sediments (Lee and Ryan 1983). All components of hydrocarbons spilled into the marine environment are degraded by microbial organisms in the water and sediments simultaneously, but at very different rates (Atlas et al. 1981, Bartha and Atlas 1987). The rate of biodegradation is influenced by oxygen concentration, temperature, nutrients (especially nitrogen and phosphorous), salinity, physical state and chemical composition of the oil, and history of previous oil spills at the site (Atlas 1981, Bartha and Atlas 1987). Biodegradation is a very slow process.

Solar radiation acting on oil on the water results in photo oxidation, or photolysis, of hydrocarbons. The molecular compounds in oil vary in their sensitivities to photolysis and are subject to photolysis at different rates. In general, photolysis decreases with decreasing water depths as light intensity decreases. In addition, photolysis is slower at higher latitudes where and when there is less sunlight, especially during the winter (Geraci and St. Aubin 1990b). At 60° N latitude (which lies just south of Ninilchik, bisecting the action area), there is approximately a tenfold decrease in the photolysis rate of benzo(a)pyrene between June and December (Zepp and Baughman 1978).

Persistence of oil from a spill in the marine environment can vary depending on the size of the spill, the environmental conditions at the time of the spill, the substrate of the shoreline, and whether the shoreline is eroding. Depending on the spill location, a small refined spill in offshore waters could evaporate in 24-28 hours without reaching nearshore waters or shorelines (BOEM 2017b).

Offshore petroleum exploration activities have been conducted in State of Alaska waters and the OCS of Cook Inlet since the 1960s. However, historical data on offshore oil spills for Cook Inlet OCS consists only of small spills. BOEM does not anticipate a small spill would persist on the water long enough for the model to predict its path in a trajectory analysis. Therefore, for small spills BOEM estimates the type of oil and number and size of spill(s). For large spills ≥1,000 bbl BOEM has analyzed trajectory. To judge the effect of a large oil spill, BOEM estimates the general source(s) of a large oil spill (such as a pipeline, platform, or well), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go (BOEM 2016a).

Approach to Estimating Exposures to Oil and Gas Spill

Estimating oil spill occurrence and potential effects on marine mammals is an exercise in probability calculations. Uncertainty exists regarding the location, number, and size of small, large, and very large oil spills, and the wind and current conditions that could occur at the time of a spill.

The following sections will go into the probabilities of various sized oil spills occurring in the area of LS 244 during the 5 years of the first incremental step, and the assumptions behind those analyses.

Based on BOEM/BSEE's oil and gas spill analyses, the only sized spills that are reasonably likely to occur during the first incremental step are small spills (<1000 bbl) (BOEM 2017b).

Small Oil Spills
Small oil spills have occurred with routine frequency and are considered likely to occur during the first incremental step as well as during subsequent steps (BOEM 2015b). Small spills during exploration activities are expected to consist of refined oils because crude and condensate oil would not be produced during exploration (BOEM 2015a).

The estimated total numbers and volumes of small refined oil spills during first incremental step activities are presented in Table 22. BOEM and BSEE estimate that approximately 0-10 spills ranging in size from <1 bbl up to 50 bbl per spill could occur during the first incremental step (BOEM 2016a). G&G activities[23] may result in 0-6 spills in total (0-2 annually), and exploration drilling may result in 0-4 small spills total (0-1 annually) during the first incremental step (BOEM 2016a). Small fuel spills associated with the vessels used for geological and geophysical activities could occur, especially during fuel transfer. For purposes of this analysis, a seismic vessel transfer spill was estimated to range from <1–13 bbl. The < 1 bbl volume considers that dry quick disconnect and positive pressure hoses function properly. The 13 bbl spill volume considers failure of spill prevention measures or rupture of fuel lines. BOEM and BSEE anticipate that most spills from the proposed action's G&G survey activities would be <1 bbl, one would be up to 13 bbl, for a total of <18 bbl during the first incremental step (BOEM 2015b). There are no reported historical fuel spills from geological or geophysical operations in the Alaska OCS.

[23] G&G activities include marine seismic surveys, geohazard surveys, and geotechnical surveys, which total 12 surveys during the First Incremental Step (BOEM 2017b). BOEM assumes all G&G activities may have an offshore fuel transfer spill (which is very conservative as no offshore transfer spills have been reported from G&G activities in the Alaska Region to date) (BOEM 2016a).

BOEM and BSEE estimate that most spills originating from the first incremental step's exploration and delineation drilling activities would range up to 5 bbl, one would be up to 50 bbl, for a total of ≤65 bbl during the first incremental step (BOEM 2017b). For the purpose of analysis, BOEM and BSEE assume that one 13 bbl spill and one 50 bbl spill would occur during the first incremental step. Refined spills of the assumed sizes (<13 bbl and 50 bbl) evaporate and disperse within 24 and 48 hours, respectively ((BOEM 2016a), Table 22).

Based on a review of potential discharges and on the historical oil spill occurrence data for the Alaska OCS and adjacent State of Alaska waters, several spills from refueling operations have been reported to the National Response Center, and all the spills were small (BOEM 2015b).

From 1975 to 2015 industry drilled 85 exploration wells in the entire Alaska OCS (BOEM 2016a). During the time of this drilling industry has had approximately 53 small spills totaling about 32 bbl or 1,344 gallons. Of the 32 bbl spilled, approximately 24 bbl were recovered or cleaned up.

Refined oil is used in exploratory drilling activity for equipment and refueling. Any small refined oil spills during seismic surveys, G&G surveys, and exploratory drilling activities is likely occur during March through December.

Table 22. Cook Inlet Lease Sale 244 Action Area Oil Spill Estimates: First Incremental Step (BOEM 2017b).

ESA Step	Phase	Exploration Activity	Source of Spill	Number of Spill(s)	Size of Spill(s) (in bbl)	Estimated Total Spill Volume	Frequency of Occurrence
First Incremental Step	Exploration	**Small Spills (Diesel and other Refined Products)**					
		Geological and Geophysical Activities[1]	Offshore	0-6	<1 or one up to13 bbl	0-<18 bbl	>99.5% chance of a small spill
		Exploration Drilling Activities	Offshore and/or Onshore Operational Spills from All Sources	0-4	5 bbl or one up to 50 bbl	0-65 bbl	
		Large Spills (Diesel or Crude)					
		Exploration Drilling Activities	N/A				Not estimated to occur
		Very Large Oil Spills (Crude)					
		Exploration Drilling Activities	N/A				Not estimated to occur $>10^{-4}$ to $<10^{-5}$ per well

Based on BOEM and BSEE's oil spill analyses, the only sized spills that are reasonably likely to occur during the first incremental step are small spills <1,000 bbl. Large and very large oil spills will be analyzed under Section 6.2 *Effects of Future Incremental Steps*.

Severity of Exposure

The severity of exposure that can result in impacts to listed marine mammals and their habitats depends on a number of factors:

- size of a spill (the flow rate and duration);
- volume of oil available to be released (reservoir size);
- type of oil;
- location;
- time of year;
- species, life history, or migratory stage; and
- manner of exposure (external only or ingestion, inhalation, or aspiration).

While marine mammals may show irritation, annoyance, or distress from oil, for the most part, an animal's need to remain in an area for food, shelter, or other biological requirements overrides any avoidance behaviors to oil (Vos et al. 2003). In addition, depending on the location of a spill, highly populated areas would be more susceptible than sparsely populated areas. Animals can be affected outside of a main spill area through oil transported by currents and oiled prey (Figure 23). The exposure to oil needs to be in sufficient quantity to produce adverse effects from either external oiling, internal absorption from ingestion of oil and prey, aspiration of oil, inhalation of volatile vapors in the air, and/or a combination of the above.

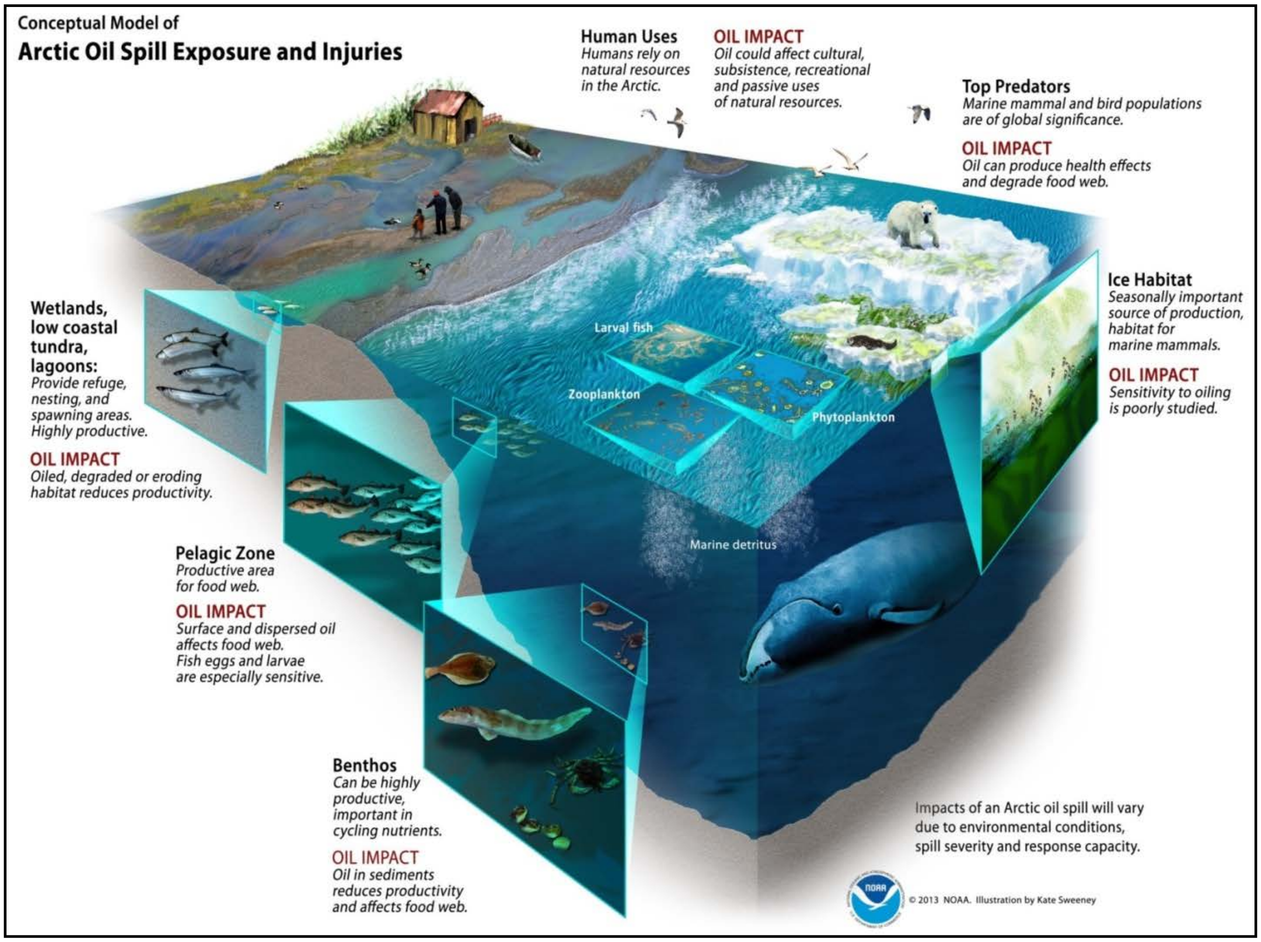


Figure 23. Conceptual model of the various pathways by which marine predators and their prey can be exposed to spilled oil.

In the following sections on anticipated oil spill exposures to listed species we qualitatively describe the potential for exposure. We use a qualitative rather than quantitative approach because we have estimates of the likelihood of the various sized oil spills occurring, but we do not have estimates on the potential for overlap between spills and listed species.

Cetacean (beluga, fin, and humpback whale) Exposure

Some small spills could be in or close to areas used by beluga, humpback, and fin whales. However, small refined oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation, and residual components rapidly disperse in open waters. If individual beluga, humpback, or fin whales were exposed to small spills, the spills would likely have minimal effects on their health due to small spills sizes, weathering, and rapid spill dispersal.

Fin whales occur in low densities in Cook Inlet during the summer months (estimated at 0.000343 individuals per km^2), while humpbacks are present at an order of magnitude higher density (0.00251 individuals per km^2). The low density of fin and humpback whales in the action area further reduce the potential for exposure to oil spills (BOEM 2015a).

The Cook Inlet Beluga Recovery Plan categorized oil spills and natural gas blowouts as a "high" potential threat to the recovery of the population, with the major effects being mortality, compromised health, reduced fitness, and reduced carrying capacity (NMFS 2016d). Oil spills and natural gas blowouts may have direct detrimental effects on Cook Inlet beluga whales (NMFS 2016d), and may also impact them secondarily by effects to their prey through changes to spawning or migration patterns, direct mortality, or potential long-term sub-lethal impacts. Spills and blowouts are considered a low-probability, but high-impact event for Cook Inlet belugas and their critical habitat.

During the first incremental step, up to 10 small refined oil spills are anticipated. If an individual whale came in direct contact with spilled oil in offshore waters it could experience inhalation and respiratory distress from hydrocarbon vapors, and less likely skin and conjunctive tissue irritation. Substantial injury and mortality due to physical contact inhalation and ingestion is possible; however, this is not likely with a small spill in Cook Inlet due to the small spill size, rapid dispersion, and evaporation, as well as the propensity for oil to not adhere to cetacean skin (BOEM 2017b). Depending on the spill location, a small refined spill in offshore waters could evaporate and disperse in 24-48 hours (BOEM 2016a) without reaching nearshore waters or shorelines.

A small fuel spill would be localized and would not permanently affect whale prey populations (e.g., forage fish and zooplankton). The amount of zooplankton and other prey lost in such a spill likely would be undetectable compared to what is available on the whales' summer feeding grounds. NMFS does not expect small spills of refined fuels at the rates predicted by BOEM to expose whales or their prey to a measureable level.

Based on the localized nature of small oil spills, the relatively rapid weathering expected for <1,000 bbl of refined oil, the small number of refueling activities in the proposed action, and the safeguards in place to avoid and minimize oil spills, the likelihood of a small spill affecting beluga, fin, or humpback whales during the first incremental step is low. However, due to the uncertainty associated with potential exposure to marine mammals, we analyze potential responses to oil spill below in Section 6.1.4.6.

Large or very large spills are not reasonably foreseeable during the first incremental step. If the stressor and species are not anticipated to overlap in time and space, then we would not anticipate that whales would be exposed to large or very large oil spills during the first incremental step. However, potential exposure and response of marine mammals to large and VLOS are described below for future incremental steps (see Section 6.2.6).

Pinniped (Steller sea lion) Exposure

Steller sea lions are commonly observed in lower Cook Inlet year-round. It is possible that some small spills may occur in, or close to, areas used by Steller sea lions. Based on the localized nature of small spills and the relatively rapid attenuation and dispersion of < 1,000 bbl of refined oil, the small number of predicted spills, the safeguards in place to avoid and minimize oil spills, and the small number of past spills, the likelihood of a small spill affecting Steller sea lions during the first incremental step of LS 244 is low. A small oil spill would be localized and would not permanently affect fish and invertebrate populations that are Steller sea lion prey. The amount of fish and other prey lost in such a spill likely would be undetectable compared to what is available throughout the range of Steller sea lions.

We conclude that the probability of a BOEM/BSEE authorized activity within the action area causing a small oil spill and exposing western DPS Steller sea lions during the first incremental step is sufficiently small as to be considered extremely unlikely to occur. However, due to the uncertainty associated with potential exposure to sea lions, we analyze potential responses to oil spill below in Section 6.1.4.6.

Large or very large spills are not reasonably foreseeable during the first incremental step. If the stressor and species are not anticipated to overlap in time and space, then we would not anticipate that seals would be exposed to large or very large oil spills during the first incremental step. However, potential exposure and response of sea lions to large and VLOS are described below for future incremental steps (see Section 6.2.6).

Cook Inlet Beluga Critical Habitat Exposure

Accidental discharges that occur as part of the LS 244 first incremental step may overlap with the designated critical habitat for the Cook Inlet beluga whale, as identified in 50 CFR §226.220 (Figure 24). There is only a small overlap between leased areas and Cook Inlet beluga whale critical habitat. While tidal fluctuations and wind could carry spilled product further into this critical habitat, the net movement of water out of Cook Inlet will help reduce exposure of most portions of this critical habitat to oil spills.

It is anticipated that Cook Inlet beluga will be concentrated in Upper Cook Inlet (Figure 7) during the summer months when many of the proposed activities associated with the first incremental step would be occurring in the lower to mid- Cook Inlet, further reducing potential for overlap.

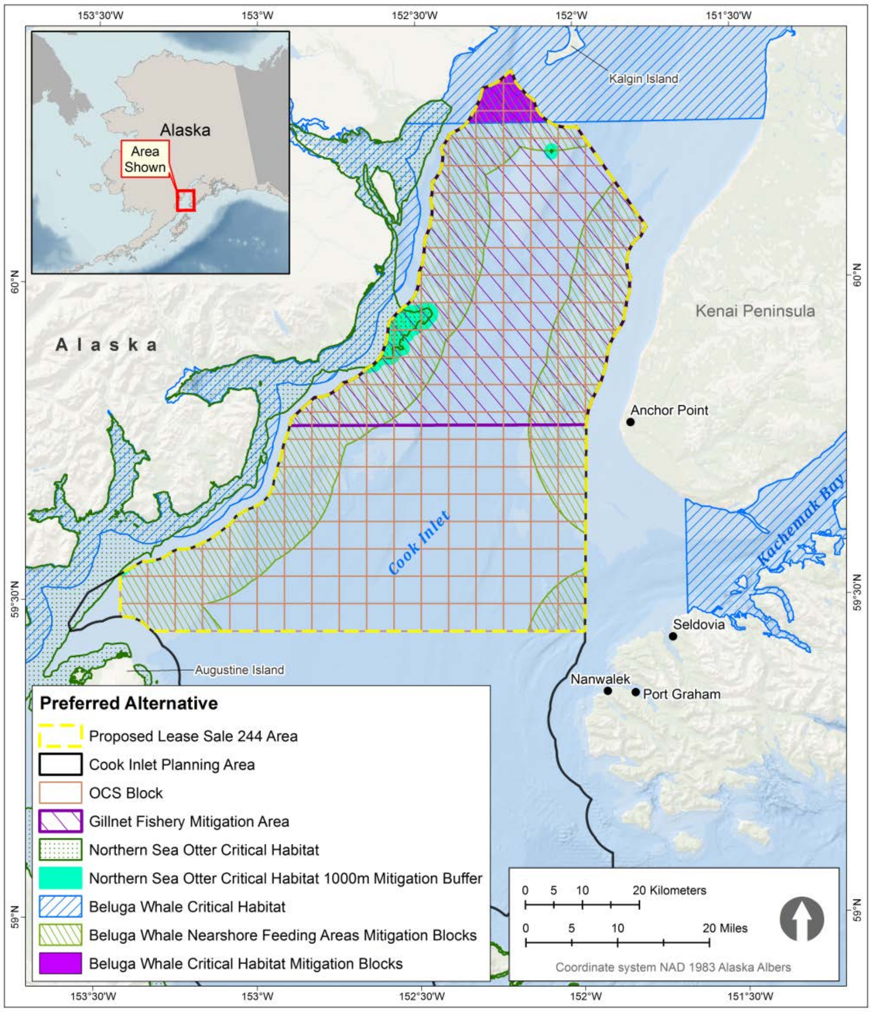


Figure 24. Biologically important areas within the proposed Lease Sale 244 area (BOEM 2017b). Purple blocks indicate lease areas overlapping with designated critical habitat for Cook Inlet beluga. Adjoining areas with blue hashing indicate designated critical habitat for Cook Inlet beluga immediately outside the lease area.

PBF1: Intertidal and subtidal waters of Cook Inlet with depths <30 feet (9m) (MLLW) and within five miles (8 km) of high and medium flow anadromous fish streams.

The intertidal and subtidal habitats within 8 km (5 mi) of anadromous fish streams within the action area are generally intact and undisturbed. Where the northeast boundary of the LS 244 area parallels the Kenai Peninsula, it is offshore from the following anadromous streams: Anchor River, Stariski Creek, Deep Creek, and Ninilchik River. Along the western boundary of the lease sale area, anadromous streams are more numerous along the coastal portions of beluga critical habitat stretching south to Douglas River at the mouth of Cook Inlet. Several anadromous streams within the action area have large returns of salmon, but belugas have not made use of these streams during commercial harvest of salmon in recent years. Since they were listed, belugas have not been reported from waters east or west of the lease sale area, although little effort outside of spring aerial surveys has been expended in that area looking for them.

Most refined spills anticipated from the first incremental step would be expected to evaporate and disperse within 24-48 hours in offshore waters without reaching the shallow areas of beluga whale critical habitat (especially Upper Cook Inlet where prey species aggregate during summer months) (BOEM 2017b). However, considering many of the proposed activities could occur outside the summer month, and could occur anywhere in the action area, there is the potential for overlap with areas identified under PBF1.

Acoustic impacts to anadromous streams and surrounding waters currently used by Cook Inlet belugas during summer salmon runs are not expected, although we have less information regarding use by belugas of streams closer to the lease sale area during the spring eulachon runs. Some streams that have notable eulachon runs may be acoustically impacted during the first incremental step, especially during seismic exploration, and adverse impacts to this PBF may occur at that time (during May and early June).

PBF 2: Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.

All primary prey species listed under PBF 2 exist in the proposed action area. Primary prey resources may also be adversely affected by oil spills. A spill in Cook Inlet could affect fish through many pathways, including adsorption to outer body, respiration through gills, ingestion, and absorption of dissolved fractions into cells through direct contact.

Consumption of contaminated prey and the reduction or mortality of local forage fish populations could create periods whereby summer prey would not be available for an undetermined time period. The fish populations in Cook Inlet eaten by belugas are vulnerable to oil contamination and subsequent ingestion by beluga whales. However, the effects of small spills on primary prey resources are expected to be minor (BOEM 2017b). Small spills are unlikely to extend far enough north to reach coastal waters used in summer by beluga whales feeding on anadromous fish species. Contamination of winter prey may occur due to small spills. But while small spills may have minor effects upon beluga winter prey, the more dispersed spatial extent of winter food resources and their deeper water habitats make it less likely that such small spills will appreciably disturb a notable portion of the entire pool of available winter prey resources available to Cook Inlet belugas. It must be noted, however, that NMFS has little information on both the spatial extent of belugas during winter or on the relative importance of each species of winter prey to the belugas' winter diet.

PBF 3: Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.

Lower Cook Inlet within the action area is not on the list of impaired water bodies (ADEC 2012). In the action area, waters are generally free of toxins and other agents of a type and amount harmful to the Cook Inlet beluga whales. However, small accidental oil spills associated with the First Incremental Step may introduce toxins within the water. The maximum amount of accidentally-released fuel spill is limited to the number of vessels associated with the proposed action, and their fuel capacity. The probability that this action will release contaminants into the water in amounts sufficient to adversely affect Cook Inlet beluga whale critical habitat is low because: (1) Cook Inlet has a large tidal exchange with a high degree of mixing; (2) There is a significant net outflow of water from the inlet due to large riverine inputs; (3) Project vessels have a small fuel capacity; and (4) There is a low probability that the vessels will release a significant volume of fuel into Cook Inlet waters due to implementation of oil spill response plans and mitigation measures.

PBF 4: Unrestricted passage within or between the critical habitat areas.

Currently, passage within or between the critical habitat areas is unrestricted in the action area. If a spill were to occur and Cook Inlet beluga avoided spill areas, passage may be restricted. However, lower Cook Inlet does not have the geographically narrow areas like upper Cook Inlet, and any restriction is anticipated to be temporary (due to the small area impacted, with dissipation expected within 24-48 hours).

We expect the probability of this action hindering passage of belugas to be extremely unlikely, so we conclude it will not likely effect PBF 4.

PBF 5: Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.

Noise is not anticipated to be a primary stressor associated with a potential oil or gas spill unless the spill is the result of a blowout. However, oil spill response activities may generate temporary intermittent noise associated with cleanup activities that could result in temporary displacement of beluga whales from their preferred habitat. As previously indicated, any noise impacts associated with oil spill response activities will be covered under an emergency consultation and are outside the scope of the proposed action.

In summary, although small spills will likely occur within Cook Inlet beluga whale critical habitat, the spills are expected to be localized and temporary in nature. Small spills that occur during the first incremental step are expected to be of refined petroleum products rather than crude oil. The most frequently-used refined products (gasoline, diesel, bunker fuel) will evaporate, disperse, and weather more rapidly than crude. We determine whether and how the quantity, quality, or availability of one or more of the PBFs of Cook Inlet beluga critical habitat are likely to change in response to the exposure of small oil spills in Section 6.1.4.6.

Steller Sea Lion Critical Habitat Exposure

Accidental discharges that occur as part of the LS 244 proposed action may overlap with the designated critical habitat for Steller sea lions (Figure 16). Effects associated with PBF exposure to large and very large oil spills will be analyzed under future incremental steps (see Section 6.2.6).

The action area contains 14 designated critical habitat areas, as identified in 50 CFR §226.202 (Table 12) including: one major rookery on Sugarloaf Island, 12 major haulouts, and a portion of the Shelikof Aquatic Foraging Area (Figure 16). The Sugarloaf Island rookery is in the action area but is 62 km (~34 nm) to the south of the LS 244 area border. The closest major haulout to the lease sale area (and in the action area) is on Ushagat Island 56 km (~30 nm) from the southern border of the LS 244 area. While project activities are not located on terrestrial zones of Steller sea lion critical habitat, they may overlap with aquatic zones and designated special foraging areas within the action area.

PBF 1: Terrestrial zones that extend 3,000 feet (0.9 km) landward from each major haulout and major rookery in Alaska.

Terrestrial zones designated as critical habitat are outside the LS 244 area but 14 are within the action area. Small oil spills may spread outside the LS 244 area towards these terrestrial zones within the action area. For the purpose of analysis, BOEM and BSEE assume that up to 10 spills may occur during the first incremental step and would total up to 83 bbl of refined oil.[24] Most small refined spills are expected to evaporate and disperse quickly in offshore waters and not contact Steller sea lion critical habitat (BOEM 2017b).

Although unlikely, if any oil sheen were to reach one or more major haulout or major rookery areas it could foul the locations and oil could be transferred to adults and pups. If this were to occur it would reduce the conservation value of the critical habitat contacted (BOEM 2017b).

Acoustic impacts to this PBF would most likely derive from aircraft activity associated with the first incremental step. However, such activity is not expected to occur sufficiently close to terrestrial zones to have an effect.

PBF 2: Air zones that extend 3,000 feet (0.9 km) above the terrestrial zone of each major haulout and major rookery in Alaska.

Accidental oil spills will not occur within the designated air zones associated with this PBF. Acoustic impacts to this PBF would most likely derive from aircraft activity associated with the first incremental step. However, such activity is not expected to occur sufficiently close to these air zones to have an effect.

PBF 3: Aquatic zones that extend 3,000 feet (0.9 km) seaward of each major haulout and major rookery in Alaska that is east of 144º W longitude.

This PBF does not occur within about 100 miles of the action area. Therefore, no stressors associated with the proposed action are anticipated to affect this PBF.

PBF 4: Aquatic zones that extend 20 nm seaward from each major rookery and major haulout west of 144° W longitude.

Designated aquatic zones stretch 20 nm seaward from each major rookery and major haulout west of 144° W longitude. While these aquatic zones occur outside the Lease Sale 244 area, they occur within the action area. Small oil spills may spread outside the LS 244 area towards these

[24] G&G activities may result in a total of six spills with an estimated total volume up to 18 bbl. Exploration Drilling activities may result in a total of four spills with an estimated total volume up to 65 bbl during the First Incremental Step (see Table 22) (BOEM 2017b).

aquatic zones within the action area. For the purpose of analysis, BOEM and BSEE assume that up to 10 spills may occur during the first incremental step and would total up to 83 bbl of refined oil.[25] Most small refined spills are expected to evaporate and disperse quickly in offshore waters (BOEM 2017b).

Although unlikely, if any oil sheen were to reach one or more major haulout or major rookery, it could temporarily foul these waters and come into contact with Steller sea lions or their prey. If this were to occur, it would reduce the conservation value of the critical habitat contacted.

Consumption of contaminated prey and the reduction or mortality of local forage fish populations could create periods whereby summer prey would not be available for an undetermined time period. The fish populations that utilize the action area and that are an essential feature of Steller sea lion critical habitat are vulnerable to oil contamination and subsequent ingestion by Steller sea lions (BOEM 2017b).

Acoustic impacts to this PBF would most likely derive from aircraft activity and rig movement associated with the first incremental step. However, such activity is not expected to occur sufficiently close to these waters to cause a measurable effect.

PBF 5: Three special aquatic foraging areas: the Shelikof Strait area, the Bogoslof area, and the Seguam Pass area, as specified at 50 CFR §226.202(c).

Part of one designated special aquatic foraging area occurs within the action area, but is over 50 km southwest of the Lease Sale 244 area, where small spills are projected to originate (Figure 16). Similar to the aquatic zone analysis, the main impact from a small spill reaching this PBF would be associated with direct contact with Steller sea lions or impacts to prey. This is unlikely to occur during the first incremental step because oil spilled during exploration and drilling is more likely to be refined, lighter weight compounds that evaporate, weather, and disperse more rapidly than crude oil. The fish populations that utilize the action area and that are an essential feature of Steller sea lion critical habitat are vulnerable to oil contamination and subsequent ingestion by Steller sea lions (BOEM 2017b). However, the probability of a small spill impacting waters at this distance is very small.

Acoustic impacts from all actions associated with the first incremental step are not expected to measurably impact these waters.

6.1.3.10 Exposure to Oil Spill Drill Activities

Oil spill response exercises or spill response practice activities may occur and could include oil spill response equipment deployment, vessels and/or aircraft traffic, unmanned aerial surveillance, and personnel or vehicle movement. The operator is required to carry out the training, equipment testing, and periodic oil spill response drills described in an Oil Spill Response Plan (OSRP).

[25] G&G activities may result in a total of six spills with an estimated total volume up to 18 bbl. Exploration Drilling activities may result in a total of four spills with an estimated total volume up to 65 bbl during the First Incremental Step (see Table 22) (BOEM 2017b).

Typical deployment exercises last only a few hours and are rarely longer that a day (BOEM 2017b). Deployment exercises are generally limited to a single skimming system involving one to six vessels, but can also be scaled up to require the operator to demonstrate their ability to carry out a larger scale response in accordance with their OSRP. Also, boom would be deployed; this includes up to 3,000 ft of ocean/conventional boom for offshore response tactics and up to 2,000 ft of coastal boom for near shore and shoreline protection tactics. This would represent a very large scale exercise that simultaneously tests the operator's competence in carrying out response operations in both types of environment. The most likely scenario would be much smaller testing of only a single tactic. An open water tactic would most likely require between 90 ft and 500 ft of conventional boom. A shoreline protection response would require between 250 ft and 500 ft of coastal boom. BSEE endeavors to coordinate with and include other Federal, State, and local agencies where appropriate to reduce impacts on government and industry (BOEM 2017b).

BOEM assumes drill exercises may range from one to three exercises per year, each lasting no more than a day. Effects associated with oil spill drill activities would be the same as those discussed above for vessel/aircraft traffic noise, and vessel strikes (see Sections 6.1.3.2-6.1.3.4), with the potential entanglement associated with deploying boom.

During spill drills, whales and pinnipeds could be exposed to harassment levels of noise from vessels and increased risk of ship strike. Whales and pinnipeds are vulnerable to entanglement with underwater lines and could be injured or killed if they become badly entangled in underwater response equipment (e.g., boom lines or anchoring systems), particularly if the equipment is left unattended. However, exposures to this threat would be reduced by implementing mitigation measures identified in the OSRPs and through consultation with NMFS (e.g., having observers on vessels, minimizing boom installation, and minimizing in water time).

6.1.4 Response Analysis

As discussed in the *Approach to the Assessment* section of this opinion, response analyses determine how listed species are likely to respond after being exposed to an action's effects on the environment or directly on listed species themselves. Our assessments try to detect the probability of lethal responses, physical damage, physiological responses (particular stress responses), behavioral responses, and social responses that might result in reducing the fitness of listed individuals. Ideally, our response analyses consider and weigh evidence of adverse consequences, beneficial consequences, or the absence of such consequences.

In addition, we try and determine whether and how the quantity, quality, or availability of one or more of the physical or biological features that led us to conclude that the area was essential for the conservation of a listed species are likely to change in response to the exposure.

6.1.4.1 Responses to Seismic Noise

Of all of the stressors we consider in this opinion, the potential responses of marine mammals upon being exposed to low-frequency seismic noise from airgun pulses have received the greatest amount of attention and study. Nevertheless, despite decades of study, empirical evidence on the responses of free-ranging marine animals to seismic noise is very limited. We examine multiple sources of seismic noise from the proposed action (2D, 3D, geohazard, and

VSP) and the potential responses of listed species to these sources in this section, and also consider effects on Cook Inlet beluga whale and Steller sea lion critical habitats.

Cetacean Responses (beluga, fin, and humpback whales)
While cetaceans are a diverse group with varied life histories and migratory patterns (see Section 4.3), they share many important traits and exhibit similar physiological and behavioral responses. In this section, whales' responses are analyzed collectively where appropriate, as the species share many similar characteristics. Where sufficient information exists for species-specific analysis, or unique effects or susceptibilities exist, individual species are discussed separately. The majority of the information provided below focuses on Cook Inlet beluga whales as they are the most commonly occurring listed whale in the action area, and a large amount of research has been done on this species. We anticipate responses from fin and humpback whales to be similar to the beluga whale in many instances but will provide information on functional hearing groups if available.

Combining instances of exposure associated with all seismic sources during the first incremental step (2D, 3D, geohazard, and VSP) results in the following maximum instances of take: approximately 159 Cook Inlet beluga whale, 52 fin whale, 2 Western North Pacific DPS humpback whales, and 40 Mexico DPS humpback[26] whales, depending on the level of activity authorized (Table 18 and Table 19 provide estimates of take for the first incremental step, of which seismic operations are a subset). All instances of take to seismic exploration are anticipated to occur at received levels ≥ 160 dB.

Given the large size of baleen whales (Western North Pacific DPS and Mexico DPS humpback whales and fin whales), and their pronounced vertical blow, it is likely that PSOs would be able to detect these whales at the surface. However, Cook Inlet beluga are more difficult to visually detect. The implementation of mitigation measures to reduce exposure to high levels of seismic sound, and the short duration and intermittent exposure to seismic airgun pulses, reduces the likelihood that exposure to seismic sound would cause take (e.g., a behavioral response that may affect vital reproduction or survival functions, or result in temporary threshold shift (TTS) or permanent threshold shift (PTS). However, despite observer effort to mitigate exposure to Level A harassment, evidence exists that some whales may be exposed to these higher received levels of noise. In 2014, a humpback whale associated with a seismic survey in Cook Inlet, Alaska was observed within the Level A harassment zone (Lomac-MacNair 2014). An anecdotal report of a humpback that appeared to be live stranded in Turnagain Arm shortly after that Level A take occurred could not be directly linked to the seismic operations. The whale survived the stranding and moved out of Turnagain Arm. Another humpback whale was exposed to a Level A sound a few days later. There were no additional Level A takes or strandings reported for this action, and no Level A takes of listed marine mammals have been reported for other seismic exploration operations in Cook Inlet.

Hearing and Vocalization

[26] Table 18 lists the total anticipated exposures of humpback whales to seismic noise when jack-up rigs are used (373), which we have divided by probability of occurrence Western North Pacific DPS (.05%), and Mexico DPS (10.5%) animals being in the area. This results in approximately 2 Western North Pacific DPS animals and 39 Mexico DPS animals potentially exposed to marine seismic, geohazard, and VSP activities.

As discussed in the *Status of the Species* section, we have no data on cetacean hearing so we assume that cetacean vocalizations are partially representative of their hearing sensitivities. NMFS categorizes Cook Inlet beluga whales in the mid-frequency cetacean functional hearing group, with an applied frequency range between 150 Hz and 160 kHz (NMFS 2016f). NMFS categorizes Western North Pacific DPS and Mexico DPS humpback whales and fin whales in the low-frequency cetacean functional hearing group, with an applied frequency range between 7 Hz and 35 kHz (NMFS 2016f).

For their social interactions, belugas emit communication calls with an average frequency range of about 200 Hz to 7 kHz (Garland et al. 2015). At the other end of their hearing range, belugas use echolocation signals (biosonar) with peak frequencies at 40-120 kHz (Au 2000) to navigate and hunt in dark or turbid waters, where vision is limited. Belugas and other odontocetes make sounds across some of the widest frequency bands that have been measured in any animal group. In the first report of hearing ranges of belugas in the wild, results of Castellote et al. (2014) were similar to those reported for captive belugas, with most acute hearing at middle frequencies, about 10-75 kHz. Estimated source level for beluga click trains average peak to peak of 218 ±5 dB re 1 µPa m (Au et al. 1987).

The sounds fin whales produce underwater are one of the most studied *Balaenoptera* sounds. Fin whales produce a variety of low-frequency sounds in the 10-200 Hz band (Watkins 1981, Watkins et al. 1987, Edds 1988, Thompson et al. 1992). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels for fin whales are 140-200 dB re 1 µPa m (Patterson and Hamilton 1964, Watkins et al. 1987, Thompson et al. 1992, McDonald et al. 1995, Clark and Gagnon 2004). In temperate waters, intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clark and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald et al. 1995). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999).

Humpback whales produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 20-5000 Hz range and intensities as high as 181 dB (Payne 1970, Winn et al. 1970a, Thompson et al. 1986b). Source levels average 155 dB and range from 144 to 174 dB (Thompson et al. 1979). Social sounds in breeding areas associated with aggressive behavior in male humpback whales are very different than songs and extend from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz (Tyack and Whitehead 1983c, Silber 1986a). These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983c). Humpback whales produce sounds less frequently in their summer feeding areas. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 seconds and source levels of 175-192 dB (Thompson et al. 1986b). These sounds are attractive and appear to rally animals to the feeding activity (D'Vincent et al. 1985, Sharpe and Dill 1997).

This information leads us to conclude that beluga whales exposed to low frequency sound from airguns are likely to respond to exposures between 150 Hz and 30 kHz, whereas fin, Mexico DPS, and Western North Pacific DPS humpback whales are likely to respond if they are exposed to low-frequency (7 Hz – 30 kHz) sounds. However, because whales are not likely to communicate at source levels that would damage the tissues of other members of their species, this evidence suggests that received levels of up to 192 dB are not likely to damage the tissues of beluga, fin, or humpback whales (Thompson et al. 1986b, Au et al. 1987, Clark and Gagnon 2004).

Occurrence

While the proposed activities may occur year round, the majority are anticipated to occur during the open water season (April-November) (for 30-90 days). Although beluga whales remain year-round in Cook Inlet, they demonstrate seasonal movements within the inlet. Ezer et al. (2013) found the majority of tagged whales were located in the lower to middle inlet (70 to 100% of tagged whales) during January through March (within the action area), near the Susitna River Delta from April to July (60 to 90% of tagged whales) (north of the action area), and in the Knik and Turnagain Arms from August to December (north of the action area). During the winter, beluga whales concentrate in deeper waters in the mid-inlet to Kalgin Island, and in the shallow waters along the west shore of Cook Inlet to Kamishak Bay (within the action area). Some whales may also winter in and near Kachemak Bay.

Fin whales have been acoustically detected in the Gulf of Alaska year-round, with highest call occurrence rates from August through December and lowest call occurrence rates from February through July (Moore et al. 2006, Stafford et al. 2007). However, fin whale sightings in Cook Inlet are rare. Fin and humpback whales are more likely to occur within the southern portion of the action area.

Humpback whales have been regularly observed in lower and mid- Cook Inlet, especially in the vicinity of Elizabeth Island, Iniskin and Kachemak Bays, and north of Anchor Point (all within the action area) (Shelden et al. 2013). Out of a total of 83 humpback whales observed by NMFS during Cook Inlet beluga aerial surveys conducted from 1993-2012, only 5 were observed as far north as the Anchor Point area (Shelden et al. 2013).

Seismic activity on LS 244 would likely impact beluga, fin, Mexico DPS, and Western North Pacific DPS humpback whales, although the level of disturbance depends on whether the whales are feeding or migrating, as well as other factors such as the age of the animal, whether it tolerates the sound, etc. In addition to targeted studies in marine mammals indicating that frequency (beyond just differing sensitivities at different frequencies) can affect the likelihood an animal incurred auditory impairment, there is increasing evidence that contextual factors other than received sound level, including activity states of exposed animals, the nature and newness of the sound, and the relative spatial positions of sound and receiver, can strongly affect the probability of behavioral response (Ellison et al. 2012).

Tolerance, Habituation, and Sensitization

While numerous studies have shown that underwater sounds from industry activities are often readily detectable by marine mammals in the water at distances of many kilometers, few studies have attempted to address habituation, sensitization, or tolerance (Nowacek et al. 2007). Tolerance is defined as ‘the intensity of disturbance that an individual tolerates without responding in a defined way’ (Nisbet 2000). Tolerance levels can be measured instantaneously and are therefore more readily demonstrated than the longer-term processes of habituation or sensitization. In fact, habituation and sensitization are identified, and distinguished from each other, by the direction of change indicated by repeated measures of tolerance taken over time. Thus, over the course of a habituation process, individual tolerance levels will increase, whereas tolerance levels will conversely decrease as individuals become sensitized to specific stimuli (Bejder et al. 2009).

Numerous studies showed that marine mammals often show no apparent response at distances more than a few kilometers from operating seismic vessels (ADNR 2017). Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to temporarily react behaviorally to airgun pulses under some conditions, at other times they have shown no overt reactions (Richardson et al. 1999, Madsen et al. 2002, Richardson et al. 2013). In general, pinnipeds and small odontocetes are more tolerant of exposure to airgun pulses than baleen whales (Richardson 2004).

Despite industry activities occurring at distances of only a few kilometers away, often times marine mammals show no apparent response or tolerance to industry activities of various types (Miller et al. 2005, Bain and Williams 2006). This is often true even in cases when the sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Weir (2008) observed marine mammal responses to seismic pulses from a 24 airgun array firing a total volume of either 5,085 in^3 or 3,147 in^3 in Angolan waters between August 2004 and May 2005. Weir recorded a total of 207 sightings of humpback whales (n = 66), sperm whales (n = 124), and Atlantic spotted dolphins (n = 17), and reported that there were no significant differences in encounter rates (sightings/hr) for humpback and sperm whales according to the airgun array's operational status (i.e., active versus silent). The airgun arrays used in the Weir (2008) study were larger than the array anticipated for use on LS 244 (total discharge volumes of 40 to 2,400 in^3). Based on this information regarding marine mammal tolerance of underwater sounds, we anticipate that some whales exposed to low frequency underwater sounds from exploration activities may tolerate seismic noise and show no apparent response. More information is needed in order to determine if the learned processes of habituation or sensitization are occurring over time as animals experience repeated exposures.

Masking and Vocal Adjustments

Whales may alter their vocal communications and communications may be masked when exposed to anthropogenic sounds. Communication is an important component of the daily activity of animals and ultimately contributes to their survival and reproductive success. Animals communicate to find food (Marler et al. 1986, Elowson et al. 1991), acquire mates (Ryan 1985), assess other members of their species (Parker 1974, Owings et al. 2002), evade predators (Greig-smith 1980), and defend resources (Zuberbuhler et al. 1997). Human activities that impair an animal's ability to communicate effectively might have significant effects on the survival and reproductive performance of animals experiencing the impairment.

Masking occurs when anthropogenic sounds and marine mammal signals overlap at spectral, spatial, and temporal scales. For the airgun sound generated from the proposed seismic surveys, sound will consist of low frequency pulses with extremely short durations (less than one second). Lower frequency anthropogenic sounds are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey noise. There is little concern regarding masking near the sound source due to the brief duration of these pulses and relatively longer silence between airgun shots (approximately 5-6 seconds). However, at long distances (over tens of kilometers away), due to multipath propagation and reverberation, the durations of airgun pulses can be "stretched" to seconds with long decays (Madsen et al. 2006b) (in much the way that distant thunder rumbles, although the sound results from one short burst of energy), although the intensity of the distant but prolonged sound is greatly reduced. This could affect communication signals used by low frequency mysticetes when they occur near the noise band and thus reduce the communication space of animals (Clark et al. 2009) and cause increased stress levels (Foote et al. 2004, Holt et al. 2009).

However, marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior by shifting call frequencies, and/or increasing call volume and vocalization rates. A few studies have demonstrated that marine mammals make vocal adjustments in the face of high levels of background noise. For example, two studies reported that some mysticete whales stopped vocalizing – that is, adjust the temporal delivery of their vocalizations – when exposed to active sonar (Miller et al. 2000, Melcon et al. 2012). Melcón et al. (2012) reported that during 110 of the 395 d-calls (associated with foraging behavior) they recorded during mid-frequency active sonar transmissions, blue whales stopped vocalizing at received levels ranging from 85 to 145 dB, presumably in response to the sonar transmissions. These d-calls are believed to attract other individuals to feeding grounds or maintain cohesion within foraging groups (Oleson et al. 2007). Beluga whales in the St. Lawrence increased the production of falling tonal calls and pulsed calls, increased the repetition of calls, and shifted call frequencies up in the presence of ship noise (Lesage et al. 1999). They also increased their call level (Lombard response) (Scheifele et al. 2005).

The number of singing humpback whales was found to decrease significantly with increasing received level of seismic survey noise (Cerchio et al. 2014).

A study conducted during the Port of Anchorage Marine Terminal Redevelopment Project, in Knik Arm of Cook Inlet, detected the hourly click rate was higher during times without (429 detected clicks/h) than with (291 detected clicks/h) construction activity; however, the difference was not statistically significant (Kendall et al. 2013). Lower frequency beluga whale vocalizations (e.g., whistles) were potentially masked, there may be have been an overall reduction in beluga vocalizations, or it is possible belugas were avoiding the area during construction activity.

Another study by Pirotta et al. (2014) showed that the probability of recording a harbor porpoise "buzz" (inter-click interval associated with attempted prey captures or social communication) declined by 15% in the ensonified area of a 2D seismic operation. The probability of occurrence of buzzes increased significantly with distance from the seismic source. This suggests that the likelihood of buzzing was dependent upon received noise intensity. Observed changes in buzzing occurrence could reflect disruption of either foraging or social activities. These effects may result from prey reactions to noise, leading to reduced porpoise foraging rates. Alternatively, foraging effort may change if porpoises adjust time budgets (that is, during the time they are vigilant, they are not as fully engaged in other behaviors) or diving behavior to avoid noise (Pirotta et al. 2014).

The effect of seismic airgun pulses on bowhead whale calling behavior has been extensively studied in the Beaufort Sea and is similar to the patterns reported in other whales. Blackwell et al. (2013) found a statistically significant drop in bowhead call localization rates with the onset of airgun operations nearby. This effect was evident for whales that were "near" the seismic operation (median distance 41-45 km) and exposed to median received levels of at least 116 dB re 1 µPa. In these whales, call localization rates dropped from an average of 10.2 calls/h before the onset of seismic operations to 1.5 calls/h during and after airgun use (Blackwell et al. 2013).

In birds, song diversity is an important index for population viability, and is influenced by anthropogenic noise (Laiolo et al. 2008, Slabbekorn and Ripmeester 2008). In bowhead whales song diversity and complexity may serve as a barometer of the impact of encroaching Arctic oil and gas development (Johnson et al. 2014). The same may be true for beluga, fin, and humpback whales songs.

Responses While Feeding

Madsen et al. (2006a) and Miller et al. (2009) tagged and monitored eight sperm whales (mid-frequency cetacean) exposed to seismic airgun surveys in the Gulf of Mexico. Sound sources were approximately 2 to 7 nm away from the whales and, based on multipath propagation received levels, were as high as 162 dB SPL re 1 µPa with energy content greatest between 0.3 kHz to 3.0 kHz (Madsen et al. 2006a). The whales showed no horizontal avoidance, although the whale that was approached most closely by the sound source had an extended resting period and did not resume foraging until the airguns had ceased firing (Miller et al. 2009). The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were 6 percent lower during exposure than control periods, suggesting subtle effects of noise on foraging behavior (Miller et al. 2009).

Feeding bowheads (low-frequency cetacean) tend to show less avoidance of sound sources than do migrating bowheads (BOEM 2015a). Bowhead whales feeding in the Canadian Beaufort Sea in the 1980s showed no obvious behavioral changes in response to airgun pulses from seismic vessels 6 to 99 km (3.7 to 61.5 mi) away, with received sound levels of 107 to 158 dB rms (Richardson et al. 1986). They did, however, exhibit subtle changes in surfacing–respiration–dive cycles. Seismic vessels approaching within approximately 3 to 7 km (2 to 4 mi), with received levels of airgun sounds of 152 to 178 dB, elicited avoidance (Richardson et al. 1986, Ljungblad et al. 1988, Richardson et al. 1995a, Miller et al. 2005). Richardson et al. (1986) observed feeding bowheads start to turn away from a 30-airgun array with a source level of 248 dB re 1 µPa at a distance of 7.5 km (4.7 mi) and swim away when the vessel was within about 2 km (1.2 mi); other whales in the area continued feeding until the seismic vessel was within 3 km (1.9 mi).

While the ranges at which bowhead and sperm whales respond to approaching seismic vessels varied, the responses that have been reported point to a general pattern. The responses of whales appear to be influenced by their pre-existing behavior: whales are more tolerant of higher sound levels when they are feeding than during migration (Miller et al. 2005, Harris et al. 2007). Data from an aerial monitoring program in the Alaskan Beaufort Sea during 2006 to 2008 also indicate that bowheads feeding during late summer and autumn did not exhibit large-scale distribution changes in relation to seismic operations (Funk et al. 2011). Feeding bowheads may be so highly motivated to stay in a productive feeding area that they remain in an area with noise levels that could, with long term exposure, cause adverse effects (NMFS 2010a).

Humpback whales on feeding grounds did not alter short-term behavior or distribution in response to explosions with received levels of about 150dB re 1µ Pa/Hz at 350Hz (Lien et al. 1993, Todd et al. 1996). However, at least two individuals were probably killed by the high-intensity, impulse blasts and had extensive mechanical injuries in their ears (Ketten et al. 1993, Todd et al. 1996).

The typical absence of behavior changes in foraging whales should not be interpreted to mean that the whales were not affected by noise. Animals that are faced with human disturbance must evaluate the costs and benefits of relocating to alternative locations; those decisions would be influenced by the availability of alternative locations, the distance to the alternative locations, the quality of the resources at the alternative locations, the conditions of the animals faced with the decision, and their ability to cope with or “escape” the disturbance (Lima and Dill 1990a, Gill and Sutherland 2001, Frid and Dill. 2002, Beale and Monaghan 2004a, b, Bejder et al. 2006, Bejder et al. 2009). Specifically, animals delay their decision to flee from predatory stimuli they detect until they decide that the benefits of abandoning a location are greater than the costs of remaining at the location or, conversely, until the costs of remaining at a location are greater than the benefits of fleeing (Ydenberg and Dills 1986). Ydenberg and Dill (1986) and Blumstein (2003) presented an economic model that recognized that animals will almost always choose to flee a site over some short distance from a predator; at a greater distance, animals will make an economic decision that weighs the costs and benefits of fleeing or remaining; and at an even greater distance, animals will almost always choose not to flee. For example, in a review of observations of the behavioral responses of 122 minke whales, 2,259 fin whales, 833 right whales, and 603 humpback whales to various sources of human disturbance, Watkins (1986) reported that fin, humpback, minke, and North Atlantic right whales tolerated sounds that occurred at relatively low received levels, had most of their energy at frequencies below or above the hearing capacities of these species, or were from distant human activities and received levels were below ambient levels. Most of the negative reactions that were observed occurred within 100 m of a sound source or when sudden increases in received sound levels were judged to be in excess of 12 dB, relative to previous ambient sounds.

As a result of using this kind of economic model to consider whales’ behavioral decisions, we would expect whales to continue foraging in the face of moderate levels of disturbance. For example, fin and humpback whales, which only feed during part of the year and must satisfy their annual energetic needs during the foraging season, may continue foraging in the face of disturbance. For smaller cetaceans, like Cook Inlet beluga whales, foraging is anticipated to occur year-round on seasonally available prey. During spring and summer, beluga whales congregate in upper Cook Inlet feeding mainly on gadids and anadromous fish, including eulachon and Pacific salmon near river mouths outside the action area. While feeding on seasonally available prey, they may be less likely to avoid noise exposure. For example, Cook Inlet beluga whales not only continue to use habitats in Upper Cook Inlet, but also spend most of their time there, despite heavy disturbance and underwater noise from maritime operations, maintenance dredging, aircraft operations, and pile driving for the POA expansion (Hobbs et al. 2000, Rugh et al. 2000, Rugh et al. 2004, Rugh et al. 2005a, Hobbs et al. 2006, Shelden et al. 2008, Shelden et al. 2009, Rugh et al. 2010a, Rugh et al. 2010b, Shelden et al. 2013b, Shelden et al. 2015a). This beluga whale behavior may, however, be taken as evidence for extreme motivation to reach important habitats in Knik Arm, rather than an indication that noise does not bother the whales (Kendall et al. 2013). Similarly, a bowhead cow accompanied by her calf is less likely to flee or abandon an area at the cost of her calf's survival. By extension, we assume that animals that choose to continue their pre-disturbance behavior would have to cope with the costs of doing so, which will usually involve physiological stress responses and the energetic costs of stress physiology (Frid and Dill 2002b, MMS 2008).

Responses While Migrating
Avoidance responses of migrating humpback whales to airgun noise appear consistent with bowhead and gray whale avoidance at received levels between 150-180 dB (Richardson et al. 1995a). Migrating humpbacks showed localized avoidance of operating airguns in the range of received levels 157-164 dB. In addition, humpback whales seemed more sensitive to seismic airgun noise while exhibiting resting behavior (McCauley et al. 2000). For resting humpback pods that contained cow-calf pairs, the mean airgun noise level for avoidance was 140 dB re 1 μPa rms, and a startle response was observed at 112 dB re 1μ Pa rms (McCauley et al. 2000). When calves are small, comparatively weak, and possibly vulnerable to predation and exhaustion, the potential continual dislocation of these animals in a confined area would interrupt this resting and feeding stage, with potentially more serious consequences than any localized avoidance response to an operating seismic vessel as seen during their migratory swimming behavior (McCauley et al. 2000).

In 9 of the 16 trials (McCauley et al. 2000), mostly single, large mature humpbacks approached the operating airgun within 100-400 m to investigate before swimming off. These whales would have received maximum air gun signals at 100 m of 179 dB re 1 μPa rms (or 195 dB re 1 μPa peak–peak). This level is equivalent to the high peak to peak 192 dB re 1μPa for humpback whale sounds recorded in Alaska (Thompson et al. 1986b). The underwater signals produced by humpback whale breaching were audibly similar to air gun signals. McCauley et al. (2000) speculate that given the similarities between airgun and breaching signals, male humpback whales may identify airgun signals as a "competitor." Frankel and Clark (1998) showed that breeding humpbacks display only a slight statistical reaction to playbacks of 60 - 90 Hz sounds with a received level of up to 190 dB. Although these studies demonstrated that humpback whales may exhibit short-term behavioral reactions to playbacks of industrial noise, the long-term effects of these disturbances on the individuals exposed to them are not known.

Studies of bowhead, gray, and humpback whales have determined that received levels of pulses in the 160-170 dB re 1 μPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. Cook Inlet beluga and fin whales are anticipated to respond in a similar manner.

Avoidance is one of many behavioral responses whales may exhibit when exposed to seismic noise. Other behavioral responses include evasive behavior to escape exposure or continued exposure to a sound that is painful, noxious, or that they perceive as threatening, which we would assume would be accompanied by acute stress physiology; increased vigilance of an acoustic stimulus, which would alter their time budget (that is, during the time they are vigilant, they are not engaged in other behavior); and continued pre-disturbance behavior with the physiological consequences of continued exposure.

Responses to Acoustic Disturbance in the Action Area

It is anticipated that, for the marine seismic airgun array (2,400 in^3) that will be used for the seismic surveys in Cook Inlet during the open water season, the distances to the 160 dB isopleth is 9.5 km (Austin and Warner 2012).

Because of their distance from the seismic source, we do not anticipate whales would change their behavior or experience physiological stress responses at received levels < 160 dB; these animals may exhibit slight deflection from the noise source, but this behavior is not likely to result in adverse consequences for the animals exhibiting that behavior.

Feeding whales, however, may cease calling or alter vocalization at significantly lower received levels; calling rates may change for some feeding whales in response to seismic noise at low received levels (85 dB-145 dB). Small portions of the action area are known to be biologically important areas for feeding for humpback and fin whales (waters adjacent to Kodiak Island) (BOEM 2016a). In addition, some lease blocks and portions of the action area overlap with Cook Inlet beluga whale feeding zones (i.e., biologically important areas) (Ferguson et al. 2015b).

Those animals that are closer to the source and not engaged in activities that would compete for their attentional resources (e.g., mating or foraging) might engage in low-level avoidance behavior (changing the direction or their movement to take them away from or tangential to the source of the disturbance), possibly accompanied by short-term vigilance, but they are not likely to change their behavioral state (that is, animals that are foraging or migrating would continue to do so). We do not anticipate that low-level avoidance or short-term vigilance would occur until noise levels are >150 dB (Richardson et al. 1995a). Again, neither low level avoidance nor short-term vigilance is likely to result in adverse consequences for the animals exhibiting the behavior.

Similarly, we would not anticipate that fin or humpback whales would devote attentional resources to a seismic stimulus beyond the 140 dB isopleth (McCauley et al. 2000). We would not anticipate startle responses with ramp-up procedures in place. Females and females with calves may avoid sound sources ≥ 140 dB. However, we would not anticipate the majority of individuals to show low-level avoidance until noise levels are ≥ 150 dB (Lien et al. 1993, Richardson et al. 1995a, Todd et al. 1996).

At some closer distance between the sound source and whale species, these species are likely to engage in more active avoidance behavior. Of the beluga, fin, and humpback whales that may be exposed to received levels ≥160 dB during the maximum two marine seismic surveys proposed during the first incremental step, some whales are likely to reduce the amount of time they spend at the ocean's surface, increase their swimming speed, change their swimming direction to avoid seismic operations, change their respiration rates, increase dive times, reduce feeding behavior, or alter vocalizations and social interactions (Richardson et al. 1986, Ljungblad et al. 1988, Richardson and Malme 1993, Greene et al. 1999, Frid and Dill. 2002, Christie et al. 2009, Koski et al. 2009, Blackwell et al. 2010, Funk et al. 2010, Melcon et al. 2012). Based on the proposed action, we would expect these kind of responses at distances between 0 and 9.5 km for the largest 2,400 in^3 seismic array, and 4 km for the 500 in^3 VSP (Austin et al. 2015). We assume that these responses are more likely to occur when whales are aware of multiple vessels in their surrounding area. However, while these exposures may all occur within the same year, they are anticipated to be separated in time and space considering a maximum of two marine surveys may occur over two years. Geohazard and geotechnical surveys may overlap temporally with marine seismic surveys, although to ensure seismic data integrity, they are anticipated to be separated in space.[27] Such spatial separation may make it more difficult for marine mammals to avoid acoustic impacts, although the disturbance zones for G&G activities are small compared to those of the seismic exploration activities.

Some whales may be less likely to respond because they are feeding. The whales that are exposed to these sounds probably would have prior experience with similar seismic stressors resulting from their exposure during previous years considering that seismic operations have been occurring in Cook Inlet since the 1960s and whales are long lived animals; that experience will make some whales more likely to avoid the seismic activities while other whales would be less likely to avoid those activities. In addition, standard mitigation measures (seismic array ramp-ups, delayed ramp-ups, power-ups, power-downs, and shutdowns) will be in place along with monitoring measures. Some whales might experience physiological stress (but not distress) responses if they attempt to avoid one seismic vessel and encounter another seismic vessel while they are engaged in avoidance behavior.

Prey Resources

Zooplankton are food sources for fin and humpback whales. In addition, they are prey resources for many prey of Steller sea lions and beluga whales. McCauley et al. (2017) conclude that marine seismic surveys can have significant negative impacts upon zooplankton populations. However, sound energy generated from seismic operations in Cook Inlet is not anticipated to negatively impact the diversity and abundance of zooplankton on more than a temporary basis, given the large tidal exchanges and presumed short time needed to bring additional zooplankton into Cook Inlet waters from outside of the area impacted by seismic exploration.

Noise generated from seismic operations can reduce the fitness and survival of fish in areas used by foraging marine mammals; however, given the small area of the project site relative to known feeding areas in the inlet for Cook Inlet beluga whales and given the fact that any physical changes to this habitat would not be likely to reduce the localized availability of fish (Fay and Popper 2012), it is unlikely that beluga whales would be affected. For Cook Inlet beluga whales, fish responses to seismic exposure are described below under critical habitat.

Pinniped Responses (Western Steller Sea Lion DPS)

Combing estimated instances of take associated with all seismic sources during the first incremental step (2D, 3D, geohazard, and VSP) results in an estimated take of approximately 1,414 western DPS Steller sea lions, depending on the level of activity authorized (Table 18 and Table 19 provide instances of exposure for the First Incremental Step, of which seismic operations are a subset). All instances of take are anticipated to occur at received levels ≥ 160 dB. These instances of take are likely to be overestimates because they assume a uniform distribution of animals and do not account for avoidance.

[27] VSP and the 2D/3D seismic survey may overlap temporally, but they are anticipated to occur in separate locations for data integrity purposes. BOEM requires minimum of ~ 24 km [15 mi] spacing between each independent survey operation.

While a single individual may be exposed multiple times, the short duration and intermittent transmission of seismic airgun pulses, combined with a moving vessel and implementation of mitigation measures to reduce exposure to high levels of seismic sound, reduce the likelihood that exposure to seismic sound would cause a behavioral response that may affect vital functions, or would cause TTS or PTS.

Steller sea lions traveling across a broad area may experience effects from seismic exploration activity on multiple occasions across time. It is not known if multiple disturbances within a certain timeframe add to the stress of an animal and, if so, what frequency and intensity may result in biologically important effects to those animals. There is likely to be a wide range of individual sensitivities to multiple disturbances, with some animals being more sensitive than others.

The ability to detect sound and communicate underwater is important for a variety of Steller sea lion life functions, including reproduction and predator avoidance. NMFS categorizes Steller sea lions in the otariid pinniped functional hearing group, with an applied frequency range between 60 Hz and 39 kHz in water (NMFS 2016f). The auditory response for pinnipeds to underwater pulsed sounds has been examined in only one study (Finneran et al. 2003) where they measured TTS onset in two captive California sea lions exposed to single underwater pulses produced by an arc-gap transducer. A measurable TTS was not observed following exposures up to a maximum level of 183 dB re 1 μPa peak-to-peak (SEL 163 dB re 1μPa^{2}s).

During the early part of the open-water season when the majority of seismic activities are anticipated to occur (May-July), Steller sea lions are occupying rookeries during their pupping and breeding season (late May to early July). No rookeries occur within lease area locations, but one major rookery occurs in the action area south of the lease areas. Based on past studies and the NMFS aerial survey data in Cook Inlet, the majority of all Steller sea lions are expected to be found south of the forelands (the northern limit of the action area) (Rugh et al. 2005, Shelden et al. 2013, 2015).

Information on behavioral reactions of pinnipeds in-water to multiple pulses involves exposures to small explosives used in fisheries interactions, impact pile driving, and seismic surveys. Several studies investigating these reactions lacked matched data on acoustic exposures and behavioral responses by individuals. That is, behavioral responses could not be definitively attributed to acoustic exposures. As a result, the quantitative information on reactions of pinnipeds in water to multiple pulses is very limited (Southall et al. 2007). However, based on the available information on pinnipeds in water exposed to multiple noise pulses, exposures in the ~150-180 dB re 1μ Pa rms generally have limited potential to induce avoidance behavior in pinnipeds (Southall et al. 2007). We anticipate this would also apply to Steller sea lions. Received levels exceeding 190 dB re 1μ Pa are likely to elicit avoidance responses, at least in some pinnipeds (Harris et al. 2001, Blackwell et al. 2004b, Miller et al. 2005). Harris et al. (2001) reported 112 instances when seals were sighted within or near the exclusion zone based on the 190 dB radius (150-250m of the seismic vessel).[28] The results suggest that seals tended to avoid the zone closest to the boat (<150m) (or to avoid noise levels greater than 190 dB).

[28] It should be noted that visual observations from the seismic vessel were limited to the area within a few hundred meters, and 79% of the seals observed were within 250 m of the vessel (Harris et al. 2001).

However, overall, seals did not react dramatically to seismic operations. Only a fraction of the seals swam away, and even this avoidance appeared quite localized (Harris et al. 2001). In the case of Steller sea lions exposed to sequences of airgun pulses from an approaching seismic vessel, we anticipate most animals would show little avoidance unless the received level was high enough for mild TTS to be likely (Southall et al. 2007).

Monitoring studies in the Alaska and Canada Beaufort Sea during 1996-2002 provided considerable information regarding Arctic seal behaviors when exposed to seismic pulses (Moulton and Lawson 2002, Miller et al. 2005). The behavioral data from these studies indicated that some seals were more likely to swim away from the source vessel during periods of airgun operations, and were more likely to swim towards, or parallel to, the vessel during non-seismic periods. A consistent relationship was not observed between exposure to airgun noise and proportions of seals engaged in other recognizable behaviors (e.g., 'looked,' 'dove'). Such a relationship might have occurred if seals tried to reduce exposure to strong seismic pulses, given the reduced airgun noise levels close to the surface, where "looking" occurs (Moulton and Lawson 2002, Miller et al. 2005).

The pinniped sighting data from the BlueCrest monitoring program in Cook Inlet reports Steller sea lions first approaching the drill rig and then turning away (Owl Ridge 2014). They also reported that many seals interrupted their normal behavior to view the rig, and then continued along in a normal manner.

Marine mammal sighting data during the Apache seismic surveys in Cook Inlet reported the most common behavior of harbor seals during non-seismic periods was "look/sink" followed by "travel," whereas during periods of active seismic shooting, "travel" was more common than "look/sink" (Lomac-MacNair et al. 2014). The 2012 Apache seismic monitoring program observed four Steller sea lions during periods without seismic airgun activity. While Steller sea lions are seen in lower Cook Inlet (in the action area) in large numbers, large numbers of Steller sea lions are not anticipated on the LS 244 lease blocks in mid-Cook Inlet. All recent sightings in mid-Cook Inlet have been sporadic and are typically limited to 1-2 animals or observations per year.

While the estimated instances of take suggest a high number of exposure events, the majority of these are anticipated to occur at received levels between ≥ 160 dB dB re 1 μPa rms where previous studies have shown limited potential to induce avoidance behavior in pinnipeds (Southall et al. 2007). Even if exposure occurred at higher received levels, the tendency of Steller sea lions to raise their heads above water, or haul out to avoid exposure to sound fields, as well as mitigation measures, reduce the potential for harassment of this species. Of the Steller sea lions that may be taken due to seismic operations, some sea lions are likely to change their behavioral state. Steller sea lions that avoid these sound fields or exhibit vigilance are not likely to experience significant disruptions of their normal behavior patterns because the vessels are transiting and the ensonified area is temporary and because pinnipeds seem rather tolerant of low frequency noise. We anticipate that few (if any) exposures would occur at received levels >160 due to avoidance of high received levels and the implementation shut down mitigation measures.

Seismic exposures are not anticipated to overlap with any rookeries or major haulouts. The proposed seismic activities also are not anticipated to take place in any special foraging areas designated as critical habitat. Very few Steller sea lions have been seen during aerial surveys of Cook Inlet (Rugh et al. 2004, Rugh et al. 2005a, Rugh et al. 2006, Shelden et al. 2008, Shelden et al. 2009, Shelden et al. 2013b). For these reasons, the duration and intensity of a seismic survey is not likely to cause a response that is a significant disruption of their normal behavioral patterns.

Steller sea lion and Cook Inlet Beluga Critical Habitat

Marine seismic surveys, ancillary geohazard surveys, and VSP surveys conducted during the first incremental step of the proposed action all produce noise that could affect Steller sea lion and Cook Inlet beluga designated critical habitat mainly through the essential feature of primary prey resources. In-depth information, including supporting references on the potential effects of the proposed action on fish, is found in the FEIS for LS 244 (BOEM 2016a), and is briefly summarized here.

The types of noises produced by seismic surveys in the proposed action could cause hearing impairment and physical, physiological, and behavioral effects on fish and fish prey. Typical behavioral responses of fish to introduced sound, such as sound from seismic surveys, include: balance disturbance (i.e., staying in normal orientation); disoriented swimming behavior; increased swimming speed; disruption or tightening of schools; disruption of hearing; interruption of important biological behaviors (e.g., feeding, reproduction); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle behaviors (BOEM 2015a).

Fish sensitivity to impulse sound such as that generated by seismic operations varies depending on the species of fish. Cod, herring, and other species of fish with swim bladders have been found to be relatively sensitive to sound, while mackerel, flatfish, and many other species that lack swim bladders have been found to have poor hearing (Hawkins 1981, Hastings and Popper 2005). Arctic cod in particular is a hearing specialist and is known to be acoustically sensitive (Normandeau Associates Inc. 2012).

An alarm response in these fish is elicited when the sound signal intensity rises rapidly compared to sound rising more slowly to the same level (Blaxter and Hoss 1981). A recent study of feeding herring schools off of Northern Norway demonstrated no observed reaction in swimming speed, swimming direction, or school size that could be attributed to an approach by an active seismic vessel shooting a 3D seismic survey (Pena et al. 2013). They attributed the unanticipated lack of response to the strong motivation for feeding combined with the slow approach of a distant seismic stimulus (Pena et al. 2013). Any such effects on fish are anticipate to be minimal and temporary and would not be expected to diminish a marine mammal species' or stocks' foraging success.

The frequency spectra of seismic survey devices cover the range of frequencies detected by most marine fish (50 to 3,000 Hz) (Pearson et al. 1992). Marine fish are likely to detect airgun acoustic output nearly 2.7 to 63 km from their source, depending on water depth (Pearson et al. 1992).

Wardle et al. (2001) observed and tracked marine fishes (primarily adult mackerel, adult pollock, and juvenile cod) on an inshore reef before, during, and after an airgun array was deployed and repeatedly fired on site. The authors found that airgun acoustic output caused startle responses in all observed fishes to an observable range of 109 m (358 ft) from the sound source and an SPL of 195 dB re 1 μPa. One of two fish tracked at the reef during the study was found to react to airguns fired at a range of 10 m (33 ft), whereby the fish immediately moved away from the airgun to a range of 30 m (98 ft). Wardle et al. (2001) concluded that fish remained close to or in the region of the airguns continuing their normal activities. However, the study's timing of airgun firings (approximately one firing per minute) did not match airgun firings used by the offshore oil and gas industry, which typically emit an acoustic energy pulse every 7 to 16 seconds, creating a regular series of strong acoustic impulses separated by silent periods, depending on survey type and depth to the target formations.

In their detailed review of studies on the effects of airguns on fish and fisheries, Dalen et al. (1996) concluded that airguns can have deleterious effects on fish eggs and larvae out to a distance of 16 ft (5.0 m), but that the most frequent and serious injuries are restricted to the area within 5.0 ft (1.5 m) of the airguns. Most investigators and reviewers (Gausland 2003, Thomson and Davis 2001, Dalen et al. 1996) have concluded that even seismic surveys with much larger airgun arrays than are used for shallow hazards and site clearance surveys have no impact to fish eggs and larvae discernible at the population or fisheries level.

Marine seismic and geohazard surveys would be conducted during the spring to late fall seasons to allow surveys to take place during the ice-free period. Because of this timing, some fish are of greater concern due to their distribution, abundance, trophic relationships, or vulnerability in relation to noise and seismic emissions. These species include (1) fishes known to be particularly important in the trophic food web, including capelin and Pacific herring (an especially sensitive herring species); and (2) Pacific salmon in their marine and estuarine migration and staging periods of life due to their broad distribution and exposure to sound over their entire life.

Migratory species at risk of spawning delays or disruptions include Pacific herring, capelin, Pacific salmon, and Pacific sand lance. Pacific herring are hearing specialists and are some of the most acoustically sensitive species occurring in the proposed LS 244 area. They are, therefore, some of the most likely fishes to exhibit displacement and avoidance behaviors due to noise and seismic activities (BOEM 2016a).

Depending on the relative scattered distribution and hypothetical frequency of post-lease seismic surveys, the effects of seismic surveys to fish populations in the proposed LS 244 area and adjacent waters are not expected to be substantial. It is possible that seismic surveys may temporarily displace fish from the area where airguns are in use. Seismic surveys are fleeting operations; hence, any fishes proximately displaced due to potential avoidance are likely to backfill the surveyed area in a matter of minutes to hours. Fishes of any life stage in close proximity to airgun emissions may suffer sub-lethal injuries that reduce individual fitness, fecundity, or survival. However, seismic surveys are not expected to have measurable lethal effects on fish populations in the defined area. Indirect effects would be spatially and temporally limited and should not produce substantial detrimental impacts to regional fish populations. Effects of seismic surveys on fish and shellfish would be minor, due their highly localized and temporary nature (BOEM 2016a).

Koshleva (1992) reported no detectable effects on the amphipod (*Gammarus locusta*) at distances as close as 0.5 m from an airgun with a source level of 223 dB re 1 μPa rms. A recent

Canadian government review of the impacts of seismic sound on invertebrates and other organisms included similar findings; this review noted "there are no documented cases of invertebrate mortality upon exposure to seismic sound under field operating conditions" (CDFO 2004). Some sub-lethal effects (e.g., reduced growth, behavioral changes) were noted (CDFO 2004). Studies on brown shrimp in the Wadden Sea (Webb and Kempf 1998) revealed no particular sensitivity to sounds generated by airguns used in with sound levels of 190 dB re 1 μPa rms at 3.3 ft. (1.0 m) in water depths of 6.6 ft. (2.0 m).

Seismic surveys would not alter the physical characteristics of either of the Steller sea lion or Cook Inlet beluga essential features identified in the critical habitat designations (i.e., terriestrial zones, or intertidal and subtidal waters <30 ft). Noise from seismic surveys conducted in close proximity to these features could make them less attractive to Steller sea lions or Cook Inlet beluga whales, or cause animals to temporarily abandon the features. However, seismic surveys would occur well north of major haulouts and rookeries of Steller sea lions (their whelping and nursing locations) and well south of beluga whale whelping and nursing areas of upper Cook Inlet. Acoustic effects from this first incremental step would not affect animals of either species engaged in birthing or nursing activities.

6.1.4.2 Responses to Pile Driving Operations

As described in the Sections 6.1.3.1, Cook Inlet beluga whales and western DPS Steller sea lions are anticipated to occur in the action area and are anticipated to overlap with noise associated with impact pile driving activities, which will occur only in the blocks in the LS 244 area. We assume that some individuals are likely to be exposed and respond to this impulsive noise source.

During the first incremental step, we estimated a total number of takes as follows: one Cook Inlet beluga whale, zero fin whales, zero Western North Pacific DPS humpback whales, zero Mexico DPS humpback whales,[29] and eight western DPS Steller sea lions (see Section 6.1.3.1, *Summary of Exposures*, Table 18 and Table 19). All instances of take are anticipated to occur at received levels ≥ 160 dB.

The effects of sounds from pile driving might result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, and masking (Richardson et al. 1995a, Nowacek et al. 2007, Southall et al. 2007). The effects of pile driving on marine mammals are dependent on several factors, including the size, type, and depth of the animal; the depth, intensity, and duration of the pile driving sound; the depth of the water column; the substrate of the habitat; the distance between the pile and the animal; and the sound propagation properties of the environment. Impacts to marine mammals from pile driving activities are expected to result primarily from acoustic pathways. As such, the degree of effect is intrinsically related to the received level and duration of the sound exposure, which are in turn influenced by the distance between the animal and the source. The further away from the source, the less intense the exposure should be. The substrate and depth of the habitat affect the sound propagation properties of the environment.

[29] Table 18 estimated a total of 2.3 humpback whales might be taken due to sound from pile driving operations. However, based on the probability of occurrence of Western North Pacific DPS (.05%) and Mexico DPS (10.5%) animals in the area, we estimated zero of these takes would accrue to ESA-listed humpback whales.

These instances of take assume a uniform distribution of animals and do not account for avoidance. The implementation of mitigation measures to reduce exposure to high levels of pile driving sound, the short duration of pile driving operations, and movement of animals reduce the likelihood that exposure to pile driving would cause a behavioral response that may affect vital functions (reproduction or survival), or would result in temporary threshold shift (TTS) or permanent threshold shift (PTS).

Whales

The combined data for mid-frequency cetaceans (e.g., belugas) exposed to multiple pulses (such as impact pile driving) do not indicate a clear tendency for increasing probability and severity of responses with increasing received levels (Southall et al. 2007). In certain conditions, multiple pulses at relatively low received levels (~80-90 dB re 1 μPa) temporarily silenced individual vocal behavior for one species (sperm whale). In other cases with slightly different stimuli, received levels in the 120-180 dB range failed to elicit observable reactions from a significant percentage of beluga whales either in the field or the laboratory (Southall et al. 2007).

As discussed in the *Status of the Species* section, we assume that beluga whale vocalizations are partially representative of their hearing sensitivities. NMFS categorizes Cook Inlet beluga whales in the mid-frequency cetacean functional hearing group, with an applied frequency range between 150 Hz and 160 kHz (NMFS 2016f). For additional discussion on beluga vocalizations see Sections 4.3.3 and 6.1.4.1.

Of the other listed whales that may occur between 0 and 5.5 km of impact pile driving, some individuals are likely to change their behavioral state – reduce the amount of time they spend at the ocean’s surface, increase their swimming speed, change their swimming direction to avoid pile driving, change their respiration rates, increase dive times, reduce feeding behavior, and/or alter vocalizations and social interactions (Frid and Dill. 2002, Koski et al. 2009, Funk et al. 2010, Melcon et al. 2012). We anticipate that few (if any) large cetacean exposures to pile-driving would occur at received levels >160 dB due to avoidance of high received levels and the implementation of standard shut down mitigation measures.

Some individual whales may be less likely to respond if they are feeding. The whales that are exposed to these sounds probably would have prior experience with similar sounds; however, depending on the outcome of prior experiences, some whales could also more likely to avoid construction activities. Some whales might experience physiological stress (but not distress) responses if they attempt to avoid one construction activity and encounter another construction activity while they are engaged in avoidance behavior.

This information leads us to conclude that listed beluga whales exposed to sounds produced by pile driving operations are likely to respond negatively. Response will vary among individuals, and may include: a startle response, avoidance of the area, alteration of breathing or vocalization rate, interruption of feeding or reproductive behaviors or production of stress hormones. Some animals may not respond in a biologically meaningful way. The likelihood of large cetaceans encountering such sounds, and reacting in a biologically meaningful way, is considerably less.

Prey

Of all known Cook Inlet beluga whale prey species, only coho salmon have been studied for effects of exposure to pile driving noise (Casper et al. 2012, Halvorsen et al. 2012). These studies defined very high noise level exposures (210 dB re 1µPa) as threshold for onset of injury, and supported the hypothesis that one or two mild injuries resulting from pile driving exposure at these or higher levels are unlikely to affect the survival of the exposed animals, at least in a laboratory environment. Hart Crowser Inc. et al. (2009) studied the effects on juvenile coho salmon from pile driving of sheet piles at the Port of Anchorage in Knik Arm of Cook Inlet. The fish were exposed in-situ (in that location) to noise from vibratory or impact pile driving at distances ranging from less than 1 meter to over 30 meters. The results of this studied showed no mortality of any of the test fish within 48 hours of exposure to the pile driving activities, and for the necropsied fish, no effects or injuries were observed as a result of the noise exposure (NMFS 2016d). Noise generated from pile driving can reduce the fitness and survival of fish in areas used by foraging marine mammals; however, given the small area of pile driving within the action area relative to known feeding areas in Cook Inlet, and the fact that any physical changes to this habitat would not be likely to reduce the localized availability of fish (Fay and Popper 2012), it is unlikely that beluga whales' prey would be affected. We consider potential adverse impacts to prey resources from pile-driving in the action area to be unlikely.

Pinniped Responses (Western Steller Sea Lion DPS)
Information on behavioral reactions of pinnipeds in water to multiple pulses involves exposures to small explosives used in fisheries interactions, impact pile driving, and seismic surveys. Several studies lacked matched data on acoustic exposures and behavioral responses by individuals where behavioral responses could be linked to acoustic exposures. As a result, the quantitative information on reactions of pinnipeds in water to multiple pulses is very limited (Southall et al. 2007). However, based on the available information on pinnipeds in water exposed to multiple noise pulses, exposures in the ~150-180 dB re 1µ Pa range (rms values over the pulse duration) generally have limited potential to induce avoidance behavior in pinnipeds (Southall et al. 2007).

The ability to detect sound and communicate underwater is important for a variety of Steller sea lion life functions, including reproduction and predator avoidance. NMFS categorizes Steller sea lions in the otariid pinniped functional hearing group, with an applied frequency range between 60 Hz and 39 kHz in water (NMFS 2016f).

The pinniped sighting data from the BlueCrest monitoring program in Cook Inlet reports Steller sea lions first approaching the drill rig and then turning away (Owl Ridge 2014). They also reported that many seals interrupted their normal behavior to view the rig, and then continued along in a normal manner. Marine mammal sighting data during the Apache seismic surveys in Cook Inlet reported the most common behavior of harbor seals during non-seismic periods was "look/sink" followed by "travel," whereas during periods of active seismic shooting, "travel" was more common than "look/sink" (Lomac-MacNair 2014).

During the early part of the open-water season when impact pile driving is anticipated to occur (May-July), Steller sea lions are occupying rookeries during their pupping and breeding season (late May to early July). No rookeries occur in the lease area where pile driving would occur, and although one major rookery designated as critical habitat is within the action area, that rookery is located well outside the impact zone for pile-driving activities. Based on past studies and the

NMFS aerial data in Cook Inlet, the majority of all Steller sea lions are expected to be found south of the forelands (Rugh et al. 2005b, Shelden et al. 2013a, Shelden et al. 2015c).

Of the Steller sea lions that may occur within the sound field of impact pile driving, some sea lions are likely to change their behavioral state – sea lions that avoid these sound fields or exhibit vigilance and raise their heads above water are not likely to experience significant disruptions of their normal behavioral patterns because the ensonified area is only temporarily disturbed, with breaks between pile driving sessions as new sections of pile are welded into place. We anticipate that few (if any) exposures from pile-driving would occur at received levels >160 due to avoidance of high received levels and the implementation of shut down mitigation measures.

Steller sea lion and Cook Inlet Beluga Critical Habitat

Effects to critical habitat, particularly primary prey resources, from pile driving operations is anticipated to be similar to other major impulsive source such as seismic operations described in Section 6.1.4.1.

6.1.4.3 Responses to Drilling Operations

As described in the *Exposure to Major Noise Sources* Section 6.1.3.1, beluga, humpback, and fin whales and Steller sea lions are all anticipated to occur in the action area and are anticipated to overlap with noise associated with drilling operations. However, of the listed marine mammals in the area, two instances of take are estimated to occur for western DPS Steller sea lions (Table 18) at received levels sufficiently high, or at distances sufficiently close, to cause behavioral harassment. However, if drillships are used, we estimate the following instances of take due to drilling noise: 58 beluga whales, 19 fin whales, 1 Western North Pacific DPS humpback whales, 14 Mexico DPS humpback whales, and 467 western DPS Steller sea lions (Table 19). In addition, drilling operations may overlap with designated critical habitat for Cook Inlet beluga whales.

Gales (1982) measured the underwater sound propagation from four fixed platforms during drilling operations and found the loudest received levels measured near the platforms (31 m [102 ft.]) were only 119-127 dB_{rms} re 1µPa m, which suggested a sound level at 1 m (3 ft.) source slightly less than 160 dB re 1µPa m.

Specific to Cook Inlet, Blackwell and Greene Jr. (2002) measured underwater drilling noise from the *Phillips A* platform rig and found noise levels and frequencies similar to those reported by Gales (1982) and McCauley (1998). However, they did record a maximum noise level of 119 dB re: 1µPa m at 1.2 km (0.75 mi), which might represent a bottom reflection as lower sound levels were recorded at closer distances to the rig. The *Spartan 151* jack-up rig was hydro-acoustically measured while operating in 2011 (Marine Acoustics 2011). The survey results showed that continuous noise levels exceeding 120 dB re 1µPa m extended out 50 m (164 ft.), and that this noise was largely associated with the diesel engines used as hotel power generators. Denes and Austin (2016b) reported that sound from the Randolph Yost jack-up rig reached the 90 percent fit threshold range of 120 dB re 1µPa m range at 329 m; mud pumping sounds at the 90 percent fit threshold range of 120 dB re 1µPa m were 225 m.

Whales (beluga, fin, and humpback)

The majority of the information provided below focuses on bowhead whales as a large amount of research has been done on these species. We anticipate responses from Cook Inlet beluga whales, fin whales, Western North Pacific DPS humpback whales, and Mexico DPS humpback whales to be similar to bowhead whales.

Belugas have been observed to show startle responses when drilling noises were played with a received level ≥153 dB re 1 μPa @ 1 m (Richardson and Würsig 1997). Off the coast of Barrow, Alaska, Richardson et al. (1991) played back recordings of drilling noise and reported “overt reactions” by beluga whales, which included: slowing down, milling, and/or reversing direction. However, Richardson et al. (1995) reported belugas outside of Cook Inlet near drill-sites and artificial islands showed little to no disturbance to the associated noise. Blackwell and Greene (2002) suggest that “belugas in industrialized areas have to a large extent habituated to noises from ships and industrial activities, when compared to animals living in remote locations such as the high Arctic.”

Drilling operations are anticipated to occur between March and December during the first incremental step. During March, Cook Inlet beluga whales are anticipated to be located in the lower to middle inlet (70-100% of tagged whales), which indicates a high potential for overlap with drilling operations. However, from April to July Cook Inlet beluga whales are anticipated to be in upper inlet near the Susitna River Delta. Limited tagging information indicates belugas begin making post-summer use of waters south of the Forelands in September (NMFS unpublished data). Our limited tagging data does not indicate potential spatial overlap with drilling operations in any months other than October and January, which speaks more to the paucity of beluga seasonal distribution data rather than to the lack of belugas near drilling operations.

Fin whales have been acoustically detected in the Gulf of Alaska year-round, with highest call occurrence rates from August through December and lowest call occurrence rates from February through July (Moore et al. 2006, Stafford et al. 2007). Fin whale observations in Cook Inlet are rare, but may be increasing in frequency. Whether that is due to increased observation effort or increasing density of fin whales in Cook Inlet is unknown. Fin and humpback whales, while present in the lease sale area, are more likely to occur within the southern portion of the action area, which is outside of the acoustic range of drilling operations in the LS 244 area. Nevertheless, both species are known to be present within the acoustic range of drilling operations in the LS 244 area (Shelden et al. 2013) during times at which drilling will take place.

Bowhead reaction to drillship-operation noise is variable. Richardson and Malme (1993) point out that the data, although limited, suggest that stationary industrial activities producing continuous noise, such as stationary drillships, result in less dramatic reactions by whales than do moving sources, particularly ships. It also appears that bowhead avoidance is less around an unattended structure than one attended by support vessels. Most observations of bowhead whales tolerating noise from stationary operations are based on opportunistic sightings of whales near ongoing oil-industry operations, and it is not known whether more whales would have been present in the absence of those operations. Other cetaceans seem to tolerate continuous or repeated noise exposure when the noise is not associated with a harmful event (BOEM 2015a). However, in order to determine if whales are habituating over time to these exposure events, long-term sequential measurements of responses by individuals to controlled stimuli are needed

(Nisbet 2000, Bejder et al. 2009). Additionally, it is not known what components of the population were observed around the drillship (e.g., adult or juvenile males, adult females, etc.) (BOEM 2015a).

Several authors noted that migrating whales are likely to avoid stationary sound sources by deflecting their course slightly as they approached a source (LGL and Greenridge 1987, Richardson et al. 1995a). McDonald et al. (2006) reported subtle offshore displacement of the southern edge of the bowhead whale migratory corridor offshore from the drilling on Northstar island.

Malme et al. (1983, 1984, 1986) studied the behavioral responses of gray whales (*Eschrictius robustus*) that were migrating along the California coast to various sound sources located in their migration corridor. The whales they studied showed statistically significant responses to four different underwater playbacks of continuous sound at received levels of approximately 120 dB. The sources of the playbacks were typical of a drillship, semisubmersible, drilling platform, and production platform. Up to 50 percent of migrating gray whales deflected from their course when the received level of industrial noise reached 116-124 dB re 1 µPa, and disturbance of feeding activity may occur at sound levels as low as 110 dB re 1 µPa (Malme et al. 1986).

Some bowheads likely avoid closely approaching drilling operations by changing their migration speed and direction, making distances at which reactions to drillships occur difficult to determine. LGL and Greenridge (1987) and Schick and Urban (2000) indicate that few whales approached within ~18 km of an offshore drilling operation in the Beaufort Sea. Results in Schick and Urban (2000) indicated that whales within hearing range of the drillship (<50 km [<31.1 mi]) were distributed farther from the rig than they would be under a random scenario. They concluded that spatial distribution was strongly influenced by the presence of the drillship but lacked data to assess noise levels. Other factors that could influence distribution relative to the drillship were support vessels and icebreakers operating in the vicinity, as well as ice thickness (Schick and Urban 2000). In a study by Koski and Johnson (1987), one whale appeared to alter course to stay 23 to 27 km (14.3 to 16.8 mi) from the center of the drilling operation. The study detected no bowhead whales within 9.5 km of the drillship, and few within 15 km. They concluded that westward migrating bowheads appeared to avoid the offshore drilling operation during the fall of 1986, and some may avoid noise from drillships at 20 km (12.4 mi) or more.

During the 2012 drilling season, bowhead whales lingered within the Chukchi Sea lease sale area, co-occurring with drilling operations by Shell at the Burger Prospect (Quakenbush et al. 2013). During fall migration, 97.6% of tagged bowhead whales entered the LS 193 area (Quakenbush et al. 2013). There were a total of 107 cetaceans observed by PSOs aboard vessels in the Chukchi Sea during the 2012 while the *Discoverer* was conducting drilling operations. However, all but two of these individuals were recorded from distant support vessels in areas where received levels from drilling activities was <120 dB (rms) (Bisson et al. 2013). The remaining two unidentified mysticetes were anticipated to have been exposed to sounds between 130-140 dB from MLC construction operations at approximately 1.6-2 km from the vessel (Bisson et al. 2013).

Although bowheads have been observed well within the ensonified zones around active drill ships, playbacks of drillship noise to a small number of bowheads demonstrated some avoidance.

Playbacks of *Explorer II* drillship noise (excluding components below 50 Hz) showed that some bowheads reacted to broadband received levels near 94-118 dB re 1 µPa – no higher than the levels tolerated by bowheads seen a few kilometers from actual drillships (Richardson et al. 1985a, Richardson et al. 1985b, Richardson et al. 1990). The playback results of Wartzok et al. (1989b) seem consistent: the one observed case of strong avoidance of *Kulluk* drilling noise was at a broadband received level ≥ 120 dB.

Two explanations may account for the seemingly different reactions of summering bowhead to playbacks versus actual drilling: tolerance and variable sensitivity. Bowheads may react to the onset of industrial noise (over several minutes) during a brief playback, but show tolerance when that sound level continues for a long period near an actual drillship. However, playback also showed that responsiveness varies among individuals and days. Thus, whales near actual drillships may have been some of the less responsive individuals - those remaining after the more responsive animals had moved out of the area. Both tolerance and variable sensitivity may have been involved (Richardson et al. 1995a).

Taken together, results of drilling noise playbacks indicated that a typical summering bowhead does not react overtly unless broadband received sound levels are ~115 dB re 1 µPa, or ~20 dB above the ambient level (Richardson et al. 1995a). Based on noise within the dominant 1/3 octave band, the reaction criteria are ~110 dB re 1 µPa or ~30 dB above ambient in that band (Richardson et al. 1990). Received industrial noise levels diminish to 20-30 dB above ambient noise level (radius of responsiveness) well before they diminish to the ambient level (radius of presumed audibility). Hence, the radius of responsiveness around a drill site is apparently much smaller than the radius of audibility (Richardson et al. 1995a).

If beluga whales, fin whales, and humpback whales avoid drilling and related support activities at distances of approximately 20 km (consistent with avoidance distances presented in Koski and Johnson 1987, LGL and Greenridge 1987, Schick and Urban (2000), this would preclude exposure of the vast majority of individuals to continuous sounds ≥120 dB re 1 µPa rms. In addition, BOEM anticipates the majority of drilling operations will be conducted from jack-up rigs, which are anticipated to be quieter than drill ships that were used in the Arctic.

While PSOs are expected to monitor for listed species during drilling operations, there are no power- or shut-down mechanisms in place if marine mammals enter this zone. However, since drilling will be a continuous noise source, it is not anticipated that marine mammals would enter into an area where they would suffer from acoustic harassment.

If drilling operations occur in the summer, most Cook Inlet beluga whales are in the upper inlet, further minimizing noise effects. Drilling operations occurring in the fall could potentially disturb and displace beluga whales feeding in the lower inlet. Humpback and fin whales may occur within the lower inlet year round and overlap with drilling noise. But due to their lower density estimates in the area, and the small ensonfied area anticipated from drilling from a jack-up rig, exposure at levels sufficient to result in behavioral harassment are unlikely.

We anticipate that the majority of whales would avoid areas within 9.5-20 km of the drill rig and should be outside the 120 dB isopleth (Koski and Johnson 1987, LGL and Greenridge 1987, Schick and Urban 2000). However, a few, less responsive individuals may be exposed within the

120 dB isopleth. These exposures may result in tolerance, slight avoidance, or displacement around drilling operations and should not rise to the level of take as defined in the ESA, and according to recent NMFS guidance on the definition of the term "harass" as it is used in the ESA (Wieting 2016).

Prey Resources

Sound energy generated from drilling operations is not anticipated to negatively impact the diversity and abundance of fish or zooplankton, and will therefore have no effect on prey populations used by whales. Temporary changes in fish distribution may result on a small spatial scale in waters immediately surrounding active drilling operations.

Pinnipeds (Western DPS Steller sea lion)

We estimated a maximum total of two possible instances where western DPS Steller sea lions might be taken due to Level B take due to noise from drilling operations during the first incremental step should jack-up rigs be used. However, should drillships be used, that take estimate increases to 467 (see Section 6.1.3.1, *Exposure to Major Noise Sources*, Table 18 and Table 19). All instances of take are anticipated to occur at received levels ≥ 120 dB. These takes are a subset of the total takes anticipated for the First Incremental Step. These take estimates are likely to be overestimates because they assume: a uniform distribution of animals, do not account for avoidance, and all drilling operations will be completed.

Steller sea lions traveling across a broad area may encounter more than one drilling operation in a year and may therefore be disturbed repeatedly by the presence of vessels or seismic survey sound or both. It is not known if multiple disturbances within a certain timeframe add to the stress of an animal and, if so, what frequency and intensity may result in biologically important effects. There is likely to be a wide range of individual sensitivities to multiple disturbances, with some animals being more sensitive than others.

NMFS categorizes Steller sea lions in the otariid pinniped functional hearing group with an applied frequency range between 60 and 39 kHz in water (NMFS 2016f). Studies of Steller sea lion auditory sensitivities have found that this species detects sounds underwater between 1 to 25 kHz (Kastelein et al. 2005a), and in the air between 250 Hz to 30 kHz (Mulsow and Reichmuth 2010a). Drilling operations are anticipated to be below 10 kHz, and should be within the auditory bandwidth for Steller sea lions.

Kastelein et al. (2005) also described the underwater vocalization of Steller sea lions, which include belches, barks, and clicks. These vocalizations may be masked by continuous noise sources such as drilling operations.

Drilling operations are anticipated to occur between March and December (for up to 180 days) during the First Incremental Step. Steller sea lions are occupying rookeries during their pupping and breeding season (late May to early July). No rookeries occur within lease area locations, but one major rookery within designated critical habitat is located in the action area, south of the LS 244 area. Steller sea lions are less likely to encounter drilling operations during the breeding season because they spend large amounts of time hauled out of the water at that time of year.

However, Steller sea lions are often spotted by PSOs during surveys in Cook Inlet so there is still the potential for exposure (e.g. Cosmopolitan, Blue Crest, and Apache).

Four of the seven Steller sea lions sightings during Cosmopolitan drilling operations in Cook Inlet reacted by approaching the rig and then turning away (Owl Ridge 2014).

The effects of offshore drilling on ice seals in the Beaufort Sea have been investigated in the past (Frost et al. 1988, Moulton et al. 2003). Frost and Lowry (1988) concluded that local seal populations were less dense within a 2 nm buffer of man-made islands and offshore wells that were being constructed in 1985-1987, and acoustic exposure was at least a contributing factor in that reduced density. Moulton et al. (2003) found seal densities on the same locations to be higher in years 2000 and 2001 after initial exposure. Thus, ringed seals were briefly disturbed by drilling activities, until the drilling and post-construction activity was concluded, then they adjusted to the environmental changes for the remainder of the activity. Pinnipeds may be disturbed by drilling activities temporarily, until the drilling and post-construction activity has been completed. The same type of reaction is anticipated for the proposed action. Steller sea lions may be disturbed during the maximum ~180 days of drilling activities per year, but then are anticipated to resume normal behavior.

Richardson et al. (1990, 1991) reported that ringed and bearded seals appeared to tolerate playbacks of underwater drilling sounds and dove within 50 m if these projected broadcasts. At that distance, the received sound level at depths greater than a few meters was ~130 dB re 1 μPa.

Moulton et al. (2003) reported no indication drilling activities at BP's Northstar oil development affected ringed seal numbers and distribution, although drilling and production sounds from Northstar could have been audible to ringed seals, out to about 1.5 km in water and 5 km in air (Blackwell et al. 2004a). Richardson and Williams (2004) found underwater noise from drilling reached background values at 2-4 km and underwater sound from vessels were sometimes detectable out to 30 km offshore. They concluded that the low-frequency industrial sounds emanating from the Northstar facility during the open-water season resulted in brief, minor localized effects on ringed seals with no consequences to ice seal populations. Adult ringed seals seem to tolerate drilling activities. Brewer et al. (1993) noted ringed seals were the most common marine mammal sighted and did not seem to be disturbed by drilling operations at the Kuvlum #1 project in the Beaufort Sea.

Southall et al. (2007) reviewed literature describing responses of pinnipeds to continuous sound and reported that the limited data suggest exposures between ~90 and 140 dB re 1 μPa generally do not appear to induce strong behavioral responses in pinnipeds exposed to non-pulsed sounds in water; no data exist regarding exposures at higher levels. It is important to note that among these studies of pinnipeds responding to continuous noise exposures in water, there are some apparent differences in responses between field and laboratory conditions. In contrast to the mid-frequency odontocetes, captive pinnipeds responded more strongly at lower levels than did animals in the field.

During Shell's 2012 drilling operations in the Chukchi Sea, a total of 396 seals were observed by PSOs. It was impossible to determine how many seals represented sightings of new individuals or if they were re-sightings of seals that already had been observed and recorded in the area.

Most (93%) of the seal sightings were recorded during periods when the pilot hole was being drilled. The remaining 26 seals were observed during mudline cellar construction. The estimated radius to received levels ≥120 dB (rms) during mudline cellar excavation was 8.1 km compared to the 1.5 km during the pilot hole drilling (Bisson et al. 2013). It was estimated that 97% of the observed pinnipeds were exposed to received levels ≤120 dB (rms). No seals were observed at distances where received levels were estimated to be ≥160 dB (rms) (Bisson et al. 2013).

While PSOs are expected to monitor the presence of marine mammals near drilling operations, there are no power- or shut-down mechanisms in place if marine mammals enter this zone. However, since both drilling and mud pumping will be a continuous noise source, it is not anticipated that marine mammals would enter into an area where they would suffer from acoustic harassment.

While there is the potential for a number of western DPS Steller sea lions to be exposed to drilling operations, the majority of these are anticipated to occur at low received levels ≤ 120 dB. Even if exposure occurred at higher received levels, the tendency of pinnipeds such as Steller sea lions to raise their heads above water, or haul out to avoid exposure to sound fields, reduces the potential for harassment of these species. Steller sea lions that avoid these sound fields or exhibit vigilance are not likely to experience significant disruptions of their normal behavior patterns.

Based on this information, we would not expect Steller sea lions that are more than 330 m from drilling operations to devote attention to that stimulus, even though received levels might be as high as 120 dB (Denes and Austin 2016). If Steller sea lions respond in a similar manner to drilling as they have with previous drilling activities and playback simulations, we would anticipate slight behavioral changes from Steller sea lions at received levels between 120 and 140 dB. These exposures may result in tolerance, slight avoidance, masking, or temporary displacement around drilling operations.

Designated Critical Habitat (Cook Inlet Beluga and Steller Sea Lion)

Drilling operations during the first incremental step could potentially affect primary prey resources identified as an essential feature of both designated Cook Inlet beluga whale and Steller sea lion critical habitats (BOEM 2017b).

Due to cod acoustic sensitivity (Normandeau Associates Inc. 2012), drilling operations may cause behavioral effects on fish and fish prey. If cod and other prey resources avoid drilling areas, this could reduce the ability of Cook Inlet beluga whales and Steller sea lions to find food and could displace these marine mammals from the area in which drilling is occurring.

However, timing restrictions on exploration drilling in beluga whale critical habitat would further reduce impacts, and no designated Steller sea lion critical habitat occurs within the LS 244 area, where exploration drilling and effects from that drilling will occur (BOEM 2017b).

6.1.4.4 Responses to Vessel Noise (Transit, Towing, Anchor Handling, and Dynamic Positioning)

As described in the *Exposure to Major Noise Sources* 6.1.3.1, and *Exposure to Vessel Noise* Section 6.1.3.2, Cook Inlet beluga, Western North Pacific DPS humpback, Mexico DPS humpback and fin whales and Steller sea lions are all anticipated to occur in the action area and are anticipated to overlap with noise associated with vessel transit, anchor handling, and dynamic positioning activities. We assume that the following number of each species will be taken as a result of noise associated with towing, anchor handling, and dynamic positioning: 90 Cook Inlet beluga whales, 29 fin whales, 1 Western North Pacific DPS humpback whale, 23 Mexico DPS humpback whales, and 722 Western DPS Steller sea lions. In addition, vessel operations will overlap with designated critical habitat for Cook Inlet beluga whales and Steller sea lions.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Cavitation increases when a vessel is towing.

Towing will occur if jack-up rigs are used. Towing will include tugs towing jack-up rigs into and out of the action area, and from well site to well site. We expect a very limited number of such towing operations (two jack-up rigs towed into the action area, 9 movements of jack-up rigs to reach all of the ten well sites, and two jack-up rigs towed out of the action area). Each of these towing operations is expected to last about 1 day or less. Towing is expected to result in about a 2200-m radius zone of sound over 120 dB re 1 μPa rms (Level B take zone) around the tugs. Sound from anchor handling and dynamic positioning is not expected to occur if jack-up rigs are used.

If drillships are used, then sounds from anchor handling and dynamic positioning will likely occur. Anchor handling is assumed to have a non-impulsive acoustic output of 195 dB (NMFS 2016g), while dynamic positioning is assumed to have a non-impulsive acoustic output of 188 dB. Anchor handling has associated with it a Level B disturbance zone of 14 km radius, while dynamic positioning has a zone of 34 km radius.

Whales (beluga, fin, and humpback)

Transiting Vessels

Reactions of marine mammals to vessels often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction of movement (NMFS 2013). Past experiences of the animals with vessels are important in determining the degree and type of response elicited from an animal-vessel encounter. Whale reactions to slow-moving vessels are less dramatic than their reactions to faster and/or erratic vessel movements. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Wartzok et al. 1989a, Richardson et al. 1995a, Heide-Jorgensen et al. 2003).

In more pristine environments like the Canadian Arctic, whales have been observed reacting to noise from ships underway at extremely long distances of 35-50 km (LGL and Greenridge 1986; Finley 1990). By contrast, observations of beluga whales in Cook Inlet have reported very little response to industrial activities. Blackwell and Greene (2002) reported belugas traveling within a few meters of the hull of a vessel near the Port of Anchorage, and belugas regularly traverse along the waterfront of the Port of Anchorage amidst industrial noise associated with shipping. Although belugas may have become somewhat habituated to industrial noises in some locations in Cook Inlet, studies have shown that in certain cases the whales will exhibit behavioral changes. Stewart (2012) studied the interactions between belugas and small boat noise in Knik Arm in an effort to document the belugas' responses to boat presence. On several occasions during this study, changes in group behavior of whales to small boats were observed; these include diving, increased travel speed, and reversing course. Belugas in the Susitna Delta area were also observed to sound and alter their breathing pattern in response to small aircraft circling overhead (Tamara McGuire, LGL, Pers. Comm.). Beluga whale researchers take great care to not disturb Cook Inlet beluga whales with their small watercraft, noting that these whales can be very sensitive to changes in engine noise (putting an engine into gear or increasing rpms.

Fin whales responded to vessels at distances of about 1 km (Edds and Macfarlane 1987). Watkins (1981) found that fin and humpback whales appeared startled and increased their swimming speed to avoid approaching vessels. Jahoda et al. (2003) studied responses of fin whales in feeding areas when they were closely approached by inflatable vessels. The study concluded that close vessel approaches caused the fin whales to swim away from the approaching vessel and to stop feeding. These animals also had increases in blow rates and spent less time at the surface (Jahoda et al. 2003). This suggests increases in metabolic rates, which may indicate a stress response. All these responses can manifest as a stress response in which the mammal undergoes physiological changes with chronic exposure to stressors. Stress responses can interrupt behavioral and physiological events, alter time budget, or cause a combination of all these stressors (Sapolsky 2000, Frid and Dill 2002b).

Humpback whale reactions to approaching boats are variable, ranging from approach to avoidance (Payne 1978, Salden 1993). On rare occasions humpbacks "charge" towards a boat and "scream" underwater, apparently as a threat (Payne 1978). Baker et al. (1983) reported that humpbacks in Hawai'i responded to vessels at distances of 2 to 4 km. Bauer and Herman (1986) concluded that reactions to vessels are probably stressful to humpbacks, but that the biological significance of that stress is unknown. Humpbacks seem less likely to react to vessels when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984). Mothers with newborn calves seem most sensitive to vessel disturbance (Clapham and Mattila 1993). Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting behavioral states to active behavioral states, which would imply that they incur an energy cost. Morete et al. (2007) reported that undisturbed humpback whale cows that were accompanied by their calves were frequently observed resting while their calves circled them (milling) and engaged in rolling interspersed with dives. When vessels approached, the amount of time cows and calves spent resting and milling respectively declined significantly.

In general, whales react strongly and rather consistently to approaching vessels of a wide variety of types and sizes. Whales are anticipated to interrupt their normal behavior and swim rapidly away if approached by a vessel. Surfacing, respiration, and diving cycles can be affected. The flight response often subsides by the time the vessel has moved a few kilometers away. After single disturbance incidents, at least some whales are expected to return to their original locations. Vessels moving slowly and in directions not toward the whales usually do not elicit such strong reactions (Richardson and Malme 1993).

While most seismic survey operations occur at relatively low speeds (1-5 knots), large vessels are capable of transiting at up to 20 knots and operate in periods of darkness and poor visibility (BOEM 2017b). Vessel operations are typically confined to the open water period (April-November).

We anticipate that noise associated with transiting vessels would drop to 120 dB within 100 meters (or less) of most vessels associated with the proposed oil and gas exploration activities (Blackwell and Greene 2002). Considering that NMFS regulations restrict approaching humpback whales within 100 yards, and BOEM/BSEE are requiring transiting vessels to stay 100 yards away from marine mammals, a whale that perceived the vessel noise is likely to ignore such a signal and devote its attentional resources to stimuli in its local environment. If animals do respond, they may exhibit slight deflection from the noise source, engage in low-level avoidance behavior, short-term vigilance behavior, or short-term masking behavior, but these behaviors are not likely to result in adverse consequences for the animals. The nature and duration of response is not anticipated to be a significant disruption of important behavioral patterns such as feeding or resting.

Towing, Anchor Handling, and Dynamic Positioning

The maximum number of instances of take due to towing, anchor handling, and dynamic positioning would occur under a scenario in which two drillships are used. Under this scenario, approximately 90 instances of Cook Inlet beluga whale take would occur, as would 29 instances of fin whale take, 1 instance of Western North Pacific DPS humpback whale take, 22 instances of Mexico DPS humpback whale take, and 722 instances of western DPS Steller sea lion take (Table 18 and Table 19 provides instances of take for which these activities are a subset). These instances of take combine all potential loud vessel sources (towing, anchor handling, and dynamic positioning) that could co-occur during the first incremental step. All instances of take are anticipated to occur at received levels ≥ 120 dB.

These estimates of take assume a uniform distribution of animals, do not account for avoidance, and represent the sum of take estimated from the multiple vessels projected to be used.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake.

Considering that anchor handling activities (and associated use of dynamic positioning, or thrusters) are anticipated to produce the loudest ensonified area in comparison to all other vessel activities, we will focus on this particular vessel activity. Anchor handling activities were found to be the loudest of the activities due to the thrusters working at their highest power during the seating of the anchors during Shell’s 2012 operations (Fairweather 2016). During Shell’s 2012 exploration drilling program, JASCO (2014) measured sound levels produced by the *Tor Viking* during activities associated with anchor handling in the Chukchi Sea at Burger. The measured level was 143 dB re 1 μPa at 860 m. The extrapolated distance to the 120 dB re 1 μPa rms threshold was approximately 14 km (JASCO Applied Sciences Inc. 2014).

Use of dynamic positioning is expected to result in source levels of 188 dB, considerably less than what results from anchor handling; however, because we lack information on the drillships that may be used in Cook Inlet and the degree to which thrusters may be used in Cook Inlet, we applied the practical spreading loss equation to that source, which resulted in an ensonified area of just over 3600 km^2, considerably larger than the 615 km^2 ensonified area used for anchor handling. However, the ensonified area calculated for anchor handling resulted from measurements of sound from that activity in Alaska, and did not rely upon the conservative practical spreading loss model.

Tugs that are actively towing drilling rigs may produce substantial cavitation and noise propagation. Noise associated with active towing operations is anticipated to drop to the 120 dB isopleth within 2,200 m.[30]

Since towing, anchor handling, and dynamic positioning will be continuous noise sources, it is not anticipated that marine mammals would enter into an area where they would suffer from TTS or PTS. In addition, vessel mitigation measures will include reduced speed during periods of low visibility and will encourage vessel operators to avoid separation of whales within groups and avoid close approaches of whales.

Of the whales that might be exposed to received levels ≥120 dB during the First Incremental Step, some whales are likely to reduce the amount of time they spend at the ocean's surface, increase their swimming speed, change their swimming direction to avoid vessel operations, change their respiration rates, increase dive times, reduce feeding behavior, or alter vocalizations and social interactions (Richardson et al. 1986, Ljungblad et al. 1988, Richardson and Malme 1993, Greene et al. 1999, Frid and Dill. 2002, Christie et al. 2009, Koski et al. 2009, Blackwell et al. 2010, Funk et al. 2010, Melcon et al. 2012). We assume that these responses are more likely to occur when multiple vessels are operating in the surrounding area.

Some whales may be less likely to respond because they are feeding. The whales that are exposed to these sounds probably would have prior experience with similar vessel stressors resulting from their exposure during previous years considering that oil and gas operations have been occurring in Cook Inlet since the 1960s and whales are long lived animals; that experience will make some whales more likely to avoid the vessel activities while other whales would be less likely to avoid those activities. Some whales might experience physiological stress (but not distress) responses if they attempt to avoid one vessel and encounter another vessel while they are engaged in avoidance behavior.

Pinnipeds (Western DPS Steller Sea Lion)

Vessel Transit

Few authors have specifically described the responses of pinnipeds to boats, and most of the available information on reactions to boats concerns pinnipeds hauled out on land or ice. However, the mere presence and movements of ships in the vicinity of seals and sea lions can

[30] Source level for multiple vessels on tow is considered 170 dB re 1 µPa rms at 1m (Denes and Austin 2016a). Using practical spreading (15 Log R), the anticipated distance to the 120 dB isopleth is 2,154 m rounded up to 2,200 m.

cause disturbance to their normal behaviors (Calkins and Pitcher 1982a, Kucey 2005, Jansen et al. 2006), and could potentially cause Steller sea lions to abandon their preferred breeding habitats in areas with high traffic (Kenyon and Rice 1961). Disturbances from vessels may motivate seals and sea lions to leave haulout locations and enter the water (Richardson 1998, Kucey 2005). The possible impact of vessel disturbance on Steller sea lions has not been well studied, yet the response by sea lions to disturbance will likely depend on the season and life stage in the reproductive cycle (NMFS 2008b). The lease area does not contain any rookeries or major haulouts. However, the action area does contain major rookeries and major haulouts outside of Cook Inlet and within Shelikof Strait; areas that are within the designated critical habitat for Steller sea lions. Up to 57 vessels may transit out of shorebases in Kenai, Nikiski, Homer, Anchorage, or other locations during the first incremental step.

The 3-mile no-transit zones are established and enforced around certain rookeries listed in 50 CFR §224.103(d). One of these rookeries, Sugarloaf Island, is within the action area, so the 3 mile no-transit zone around this major rookery provides further protection from vessel activity. In addition, NMFS's guidelines for approaching marine mammals discourage vessels approaching within 100 yards of haulout locations.

Vessels that approach rookeries and haulouts at slow speed (and remain more than three miles from major rookeries), in a manner that allows sea lions to observe the approach, should have less effects than vessels that appear suddenly and approach quickly (NMFS 2008b). Sea lions may become accustomed to repeated slow vessel approaches, resulting in minimal response. Although low levels of occasional disturbance may have little long-term effect, areas subjected to repeated disturbance may be permanently abandoned (NMFS 2010b).

Vessels produce sound that may elicit behavioral changes in sea lions, mask their underwater communications, mask received noises, and cause them to avoid noisy areas. Richardson (1995) found vessel noise does not seem to strongly affect pinnipeds that are already in the water, explaining that hauled out seals often respond more strongly to the presence of vessels, typically fleeing into the water, increasing the risk of injury to themselves and smaller individuals that may be trampled. The same is true of Steller sea lions (NMFS 2010b).

Towing, Anchor Handling, and Dynamic Positioning

The estimate of take during the first incremental step due to towing, anchor handling, and dynamic positioning activities of western DPS Steller sea lions was approximately 722 (Table 18 and Table 19 provide total instances of exposure for which these activities are a subset). These instances of take combine take estimates for each discrete major vessel noise source (e.g. towing, anchor handling, and DP) , acknowledging that some of these sources of take may co-occur.

These estimates of take are likely to be overestimates because they assume a uniform distribution of animals, do not account for avoidance or mitigation measures, and represent the sum of the exposures associated with multiple activities, some of which may co-occur.

Considering that anchor handling activities (and associated use of dynamic positioning, or thrusters) are anticipated to produce the loudest noise compared to all other vessel activities, we will focus on this stressor. Anchor handling activities were found to be the loudest of the activities due to the thrusters working at their highest power during the seating of the anchors during Shell's 2012 operations (Fairweather 2016). During Shell's 2012 exploration drilling program, JASCO (2014) measured sound levels produced by the *Tor Viking* during activities associated with anchor handling in the Chukchi Sea at Burger. The measured level was 143 dB re 1 μPa at 860 m. The extrapolated distance to the 120 dB re 1 μPa rms threshold to approximately 14 km (JASCO Applied Sciences Inc. 2014).

Use of dynamic positioning is expected to result in source levels of 188 dB, considerably less than what results from anchor handling; however, because we lack information on the drillships that may be used in Cook Inlet and the degree to which thrusters may be used in Cook Inlet, we applied the practical spreading loss equation to that source, which resulted in an ensonified area of just over 3600 km^2, considerably larger than the 615 km^2 ensonified area used for anchor handling. However, the ensonified area calculated for anchor handling resulted from measurements of sound from that activity in Alaska, and did not rely upon the conservative practical spreading loss model.

Tugs that are actively towing drilling rigs may produce a lot more cavitation and noise propagation. Noise associated with active towing operations is anticipated to drop to the 120 dB isopleth within 2,200 m.[31]

Of the 722 instances of Western DPS Steller sea lion takes that may occur due to noise from towing, anchor handling, and dynamic positioning sounds of ≥120 dB, some sea lions may change their behavior, alter their vocalizations, mask received noises, increase vigilance, and avoid noisy areas (Richardson and Malme 1993, Richardson et al. 1995a, Rogers 2003, Blackwell et al. 2004b, Rossong and Terhune. 2009). We assume that these responses are more likely to occur when sea lions are aware of multiple vessels in their surrounding area.

Since towing, anchor handling, and dynamic positioning will be continuous noise sources, it is not anticipated that marine mammals would enter into an area where they would suffer from TTS or PTS. Mitigation measures restricting vessel speed and approach and requiring PSOs on board to spot nearby sea lions will minimize the impacts of the potential exposures. Thus, despite the fact that there may be a large estimate of Steller sea lion take due to continuous sounds ≥120 dB, the impact of towing, anchor handling, and dynamic positioning on western DPS Steller sea lions is anticipated to be minor.

Cook Inlet Beluga and Steller Sea Lion Critical Habitat

Vessel Transit

Non-tug vessel transits that occur during the first incremental step could potentially affect primary prey resources identified as an essential feature of Cook Inlet beluga whale critical habitat, and could affect waters within Steller sea lion critical habitat (BOEM 2017a). While vessel activity is already present in the action area, activities associated with the first incremental step will increase the chronic vessel noise in the action area, primarily within the LS 244 area, and between that area and established ports. The degree of this increase remains unknown, but

[31] Source level for multiple vessels on tow is considered 170 dB re 1 μPa rms at 1m (Denes and Austin 2016a). Using practical spreading (15 Log R), the anticipated distance to the 120 dB isopleth is 2,154 m rounded up to 2,200 m.

the contribution of this action to vessel traffic within the action area is expected to be over 2000 additional vessel days (Table 20). Total vessel use of the area in units of vessel days is unavailable.

Because project vessels will depart and arrive from established ports and will not operate near shore (BOEM/BSSE 2016a), vessel transit is expected to have minimal impact on Cook Inlet beluga whale critical habitat PBF1 (Intertidal and subtidal waters in Cook Inlet less than 30 feet deep and within 5 miles of anadromous fish streams provided in 50 CFR §226.220(c)(1)).

Sound from transiting vessels will likely be detected by primary prey species of beluga whales comprising critical habitat PBF 2 (as listed in 50 CFR §226.220(c)(2)). Vessel sounds that may be most readily detected by fish will be the higher frequency sounds associated with cavitation and propeller and machinery harmonics (BOEM/BSSE 2016a). However, the action area is not within Area 1 of beluga whale critical habitat, where the majority of summer feeding of primary prey species typically occurs. Furthermore, *Lease Sale 244 Stipulation No. 1 – Protection of Fisheries* will reduce conflicts between oil and gas exploration and fishing activities (BOEM 2016a). By extension, this lease sale stipulation is expected to minimize or avoid disturbance of large concentrations of anadromous fish staging near their spawning streams.

Spatial modelling of limited satellite tag data from Cook Inlet beluga whales indicates that their use of critical habitat south of Kalgin Island is low, with use of southern critical habitat areas being lowest during the ice-free portions of the year (MML unpublished data, April, 2017), when activities associated with the first incremental step are highest.

The action area is within an area most commonly used by beluga whales during winter; a time of year for which there is essentially no aerial survey-based distribution data, little information on winter diet composition, and tag data from only 9 individual whales (MML unpublished data, April, 2017). We expect that the action will have effects on winter prey (e.g. Pacific cod, walleye pollock, saffron cod, and yellowfin sole) through acoustic disturbance. These effects will be most pronounced during the ice-free season, affecting those winter prey items that are present in the area during summer. However, such effects would likely be undetectable by the time that beluga whales avail themselves of these winter food resources (December through May).

We expect that acoustic disturbance from transiting vessels will impact beluga summer food resources (e.g. salmon and eulachon) as these anadromous fish transit through the action area on their migration to spawning streams. However, while vessel traffic may cause a startle or flight response in these prey species, such effects are not expected to impact prey survival or productivity, and are expected to be undetectable by the time these fish reach the mouths of their spawning streams.

Vessel noise dominates the low-frequency bands and has a maximum sound level that ranges between approximately 160 to 220 dB re 1 μPa @ 1 m with maximum energy between 10 Hz to 1 kHz and a steep negative slope above 80 Hz. The majority of the broadband sound from vessels occurs below the most sensitive portions of beluga whale hearing, mitigating its effects upon Cook Inlet beluga whale critical habitat PBF 4 (unrestricted passage within or between critical habitat areas provided in 50 CFR §226.220(c)(4)) and PBF 5 (in-water noise below levels resulting in abandonment of critical habitat provided in 50 CFR §226.220(c)(5)). Vessel noise is expected to attenuate to levels not expected to harass beluga whales within about 100 m of the vessel (Table 9), making it unlikely that non-tug vessel traffic would impede access to critical habitat areas or cause abandonment of these areas. However, vessel traffic near Kalgin Island during winter could have disproportionately large effects upon beluga access to critical habitat if anecdotal reports of relatively high levels of beluga use of this area during winter are correct (NMFS unpublished data).

Steller sea lion critical habitat does not occur within the Lease Sale 244 area, but it does exist within the action area (Figure 16). Disturbance to Steller sea lions from vessel traffic may originate from either vessel noise or visual disturbance caused by the physical presence of the vessel. Effects from the physical presence of vessels on marine mammals are difficult or impossible to distinguish from the effects due to vessel noise. It is probable that the degree of disturbance from the physical presence of a vessel may depend on a variety of factors such as proximity to haulouts and rookeries, vessel size and speed, visibility (water column and atmospheric), sea state, ambient noise, and perhaps vessel lighting (BOEM/BSSE 2016a). The suite of marine mammal disturbance behaviors resulting from noise (including avoidance, attraction, increased swimming speed, and dive time) are largely the same as those from physical presence and, in some cases, may impact spatial distribution, movement pattern, and reduced abundance of marine mammals (BOEM/BSSE 2016a).

Because the spatial extent of the zone of acoustic harassment from non-tug vessels is expected to extend only about 100 m from each vessel, we expect the most likely way in which transiting vessels are likely to affect Steller sea lion critical habitat will derive from their visual presence near rookeries and haulouts. Vessel closure areas are listed at 50 CFR §224.103(d) and include waters within 3 nautical miles (5.5 km) of Sugarloaf rookery. This vessel closure area is important to avoid visual effects to Steller sea lions on their rookery. Similar avoidance by transiting vessels of major haulouts listed in Table 12, and shown in Figure 16 and Figure 17, would also minimize such effects. Vessels are prohibited from approaching within 3 nm of the rookeries listed in 50 CFR §224.103(d), and we do not expect vessels associated with this action to approach within 3 nm of haulouts, given the location of established ports relative to the LS 244 area, and the lack of need for the vessels to approach so close to rocky shorelines. While vessel traffic is expected to occur within the aquatic zone that extends 20 nm (37 km) seaward of major haulouts and rookeries, and may also occur within the Shelikof Strait aquatic foraging area, we do not expect the transitory nature of these vessels, and their relatively small acoustic footprint, to have a measurable effect upon the value of Steller sea lion critical habitat.

Towing, Anchor Handling, and Dynamic Positioning

Effects from tugs towing jack-up rigs, drillship anchor handling, and dynamic positioning may affect Cook Inlet beluga whale and Steller sea lion critical habitat, primarily through acoustic impacts, although small (insignificant) impacts to critical habitat may result from disturbance of substrate during anchor handling. In this section, we concern ourselves primarily with the response of critical habitat to the acoustic impacts resulting from these actions.

Towing, that is, tugs towing jack-up rigs into and out of the action area, and from well site to well site, is expected to result in about a 2200-m radius zone of sound over 120 dB re 1 μPa rms (Level B take zone) around the tugs themselves. We expect a very limited number of such towing operations (two jack-up rigs towed into the action area, 9 movements of jack-up rigs to reach all of the ten well sites, and two jack-up rigs towed out of the action area). Each of these towing operations is expected to last about 1 day or less, making a small additional contribution of sound to the overall soundscape of Cook Inlet; less than one percent of expected take of all listed species in Cook Inlet is due to movement of jack-up rigs by tugs (Table 18).

The effects of rig movement by tugs on Cook Inlet beluga critical habitat is expected to be similarly small. Slow moving tugs may result in temporary avoidance of small areas by beluga prey species, but it is not expected to cause a startle response in prey or to result in unrestricted passage of belugas within or between critical habitat areas. Similarly, abandonment of critical habitat by belugas due to this episodic, low-occurrence-over-time activity is not expected. The season during which jack-up rig movement is expected to occur coincides with presumed lower use of the southern extent of critical habitat by belugas (MML unpublished data, April, 2017), further mitigating what are already expected to be small effects.

Except for the few movements of jack-up rigs into and out of the lease-sale area, sound from rig movement is not expected to overlap with Steller sea lion critical habitat. Sound from anchor handling and dynamic positioning is not expected to occur if jack-up rigs are used.

Should drillships be used for drilling of wells, then sound from anchor handling and dynamic positioning will likely occur within both Cook Inlet beluga whale and Steller sea lion critical habitat. These two vessel-related activities account for nearly 30 percent of this action's estimated take of listed species due to sound intensities capable of causing Level B take (Table 19). Anchor handling is assumed to have a non-impulsive acoustic output of 195 dB (NMFS 2016g), while dynamic positioning is assumed to have a non-impulsive acoustic output of 188 dB (BOEM 2016a).

Sounds associated with these two activities are likely to have output at higher frequencies that are detectable by both winter and summer prey species of Cook Inlet beluga whales. As such, avoidance or a startle response of prey may be expected, but effects from such responses are not expected to be detectable by the time that Cook Inlet belugas make notable use of the southern portions of critical habitat, where such effects upon winter prey species may take place. Effects of these activities upon Cook Inlet beluga summer prey species are not expected to last until those affected summer prey reach the vicinity of their spawning streams in Upper Cook Inlet, where beluga whales are most likely to exploit concentrations of these prey items for food.

There will be overlap between Steller sea lion critical habitat and the calculated ensonified areas associated with these two activities, especially with the aquatic zone surrounding the Sugarloaf Island rookery. However, the vessels from which these sounds will emanate will be located well outside of Steller sea lion critical habitat boundaries. As such, while the calculated ensonified areas will overlap to some minor extent with designated critical habitat, we expect that the vessels producing these noises will be sufficiently far from Steller sea lion critical habitat to avoid visual impact upon animals within critical habitat.

As with other fish, we expect Steller sea lion prey within critical habitat to react to sound well above detection thresholds. Fish will react or alter behavior when the sound level increased to about 20 dB above the detection level of 120 dB (Ona 1988); however, the response threshold can depend on the time of year and the fish's physiological condition (Engas et al. 1993). Given that, we expect that sounds from anchor handling and dynamic positioning will have attenuated sufficiently to avoid eliciting a response in prey items within 5 km of the sound source (assuming a source level of 195 dB, practical spreading loss, and a fish disturbance threshold of 140 dB). This will result in an exceedingly small-to-zero overlap between the acoustic effects of anchor handling and dynamic positioning upon Steller sea lion prey within Steller sea lion critical habitat, with the amount of overlap depending upon the location of well sites within the lease sale area.

6.1.4.5 Responses to Other Stressors

As we indicated in *Sections 6.1.3.3-6.1.3.7*, Exposure to Aircraft Noise, Vessel Strike, Seafloor Disturbance, Trash and Debris, and non-seismic Geohazard Surveys, listed species are extremely unlikely to be exposed to associated stressors and thus effects should be considered improbable, or the exposures that would occur would not reach the level that constitutes a take and effects from those exposures are therefore considered minor. We note here that we lack sufficient information on which to assess the probability of entanglement due to the accidental discarding of uncut, non-biodegradable closed loops. Moreover, the effects from these other stressors (Exposure to Aircraft Noise, Vessel Strike, Seafloor Disturbance, Trash and Debris, and non-seismic Geohazard Surveys), in combination with the effects from the stressors addressed in this section (Responses to Seismic Noise, Pile Driving Operations, Drilling Operations, Vessel Noise, Oil and Gas Spills, and Oil Spill Drill Activities), are unlikely to occur or the exposures would cause only an undetectable to minimal impact on endangered and threatened species and designated critical habitat within the action area.

As we discussed in the *Approach to the Assessment* section of this opinion, endangered or threatened animals that are not directly or indirectly exposed to a potential stressor cannot respond to that stressor. Because listed whales and pinnipeds are not likely to be directly or indirectly exposed to these stressors, they are not likely to respond to that exposure or experience reductions in their current or expected future reproductive success as a result of those responses. An action that is not likely to reduce the fitness of individual whales or pinnipeds would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

6.1.4.6 Responses to Oil and Gas Spills

The empirical evidence available did not allow us to estimate the number of listed marine mammals that are likely to be exposed to oil spills associated with BOEM and BSEE's authorized activities during the first incremental step (years 1-5). Nevertheless, we assume that any individuals that overlap in time and space with a potential spill may be exposed.

There are different probabilities of potential occurrence between the various sized oil spills: small: >99.5 percent chance, large: not expected to occur, and VLOS: not expected to occur (BOEM 2017b). It is more likely that this first incremental step will result in a small oil spill originating from within the LS 244 area than from elsewhere in the action area. It is also more likely that a small spill will occur than a large or very large spill. However, the general responses of individual animals to exposure to oil do not differ with the size of a spill. The size of the spill determines the number of individuals that will be exposed and duration of exposure.

Toxic substances can impact animals in two major ways. First, the acute toxicity caused by a major point source of a pollutant (such as an oil spill or hazardous waste) can lead to acute mortality or moribund animals with a variety of neurological, digestive, and reproductive problems. Second, toxic substances can impair animal populations through complex biochemical pathways that suppress immune functions and disrupt the endocrine balance of the body, causing poor growth, development, reproduction, and reduced fitness. Toxic substances come in numerous forms, with the most-recognized being the organochlorines (OCs; mainly PCBs and DDTs), heavy metals, and polycyclic aromatic hydrocarbons (PAHs). There are also a number of "emerging" contaminants, e.g., flame retardant polybrominated diphenyl ethers (PBDEs), which could also be impacting marine mammals.

If an oil spill were to occur, marine mammals and their habitats may be adversely impacted. Marine mammals could experience adverse effects from contact with hydrocarbons, including:

- Inhalation of liquid and gaseous toxic components of crude oil and gas;
- Ingestion of oil and/or contaminated prey;
- Fouling of baleen (fin and humpback whales);
- Oiling of skin, eyes, and conjunctive membranes causing corneal ulcers, conjunctivitis, swollen nictitating membranes, and abrasions.

Available evidence suggests that mammalian species vary in their vulnerability to short-term damage from surface contact with oil and ingestion. While vulnerability to oil contamination exists due to ecological and physiological reasons, species also vary greatly in the amount of information that has been collected about them and about their potential oil vulnerability.

Ingestion of hydrocarbons can irritate and destroy epithelial cells in the stomach and intestine of marine mammals, affecting motility, digestion, and absorption, which may result in death or reproductive failure (Geraci and St. Aubin 1990b). Direct ingestion of oil, ingestion of contaminated prey, or inhalation of volatile hydrocarbons transfers toxins to body fluids and tissues causing effects that may lead to death, as suspected in dead gray and harbor seals found with oil in their stomachs (Engelhardt 1982, Geraci and St. Aubin 1990b, Frost et al. 1994, Spraker et al. 1994, Jenssen 1996). Additionally, harbor seals observed immediately after oiling appeared lethargic and disoriented, which may be attributed to lesions observed in the thalamus of the brain (Spraker et al. 1994).

BOEM and BSEE anticipate up to 10 small spills may occur during the first incremental step, with all anticipated spills totaling up to 83 bbl (BOEM 2016a).

Accidental discharges occurring as part of the LS 244 proposed action may occur within designated critical habitat for Cook Inlet beluga whale (Figure 10), and Steller sea lion (Figure 16). An accidental discharge could render areas containing the identified essential features unsuitable for use. In such an event, haulouts and rookeries could be oiled. Primary prey species could become contaminated, experience mortality, or be otherwise adversely affected by spilled oil.

Whales (beluga, fin, and humpback)

Depending on the timing of the spill, Cook Inlet beluga, fin, Western North Pacific DPS humpback, and Mexico DPS humpback whales could briefly be exposed to small spills of refined oil during the First Incremental Step. The rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh refined oil and disturbance from response related noise and activity limits potential exposure of whales to prolonged inhalation of toxic fumes. Surface feeding whales could ingest surface and near surface oil fractions with their prey, which may be contaminated with oil components. Ingestion of oil may result in temporary and permanent damage to whale endocrine function and reproductive system function, but is not likely for small oil spills.

The Recovery Plan for the Cook Inlet Beluga Whale (NMFS 2016d) categorized oil spills and natural gas blowouts as a “high” potential threat to the recovery of the population, with the major effects being mortality, compromised health, reduced fitness, and reduced carrying capacity. Oil spills and natural gas blowouts may also impact Cook Inlet beluga whales by effects to their prey through changes to spawning or migration patterns, direct mortality, or potential long-term sub-lethal impacts (Marty et al. 1997; Moles, Rice, and Norcross 1994; Murphy et al. 1999 in (NMFS 2016d).

Cook Inlet beluga whale calves are born from mid-May (Calkins 1983) until October (Tamara McGuire, LGL, pers. Comm. 2017), but have not recently been observed in the action area (largely because surveys are not timed appropriately to observe spatial distribution of these calves). Although humpback whales do not give birth in the action area, humpback whale calves have been spotted in the action area (Campbell 2014). Calves could be more vulnerable than adults to vapors from a spill, because they take more breaths than their mothers and spend more time at the surface (BOEM 2015a).

Research has shown that while cetaceans are capable of detecting oil, they do not seem to be able to avoid it. For example, during the spill of Bunker C and No. 2 fuel oil from the *Regal Sword*, researchers saw humpback and fin whales, and a whale tentatively identified as a right whale, surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts (Geraci and St. Aubin 1990b).

The greatest threat to cetaceans is likely from the inhalation of the volatile toxic hydrocarbon fractions of fresh oil which can damage the respiratory system (Hansen 1985, Neff 1990), cause neurological disorders or liver damage (Geraci and St. Aubin 1990b), have anesthetic effects (Neff 1990), and cause death (Geraci and St. Aubin 1990b). However, for small spills there is anticipated to be a rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh refined oil which limits potential exposure of whales to prolonged inhalation of toxic fumes.

Whales could be exposed to a multitude of short and longer term additional human activity associated with initial spill response, cleanup, and post-event human activities that include primarily increased and localized vessel and aircraft traffic associated with reconnaissance and monitoring. These activities would be expected to be intense during the spill cleanup operations and continue at reduced levels for potentially decades post-event. Specific cetacean mitigation would be employed as the situation requires and would be modified as needed to meet the needs of the response effort. The response contractor would be expected to work with NMFS and state officials on wildlife management activities in the event of a spill. We will not evaluate the potential effects associated with spill response and cleanup as part of this consultation. However, oil spill response activities have been previously consulted on by NMFS as part of the *Unified Plan* (AKR-2014-9361).

Based on the localized nature of small oil spills, the relatively rapid weathering expected for <1,000 bbl of oil, the small number of refueling activities in the proposed action, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of a BOEM/BSEE authorized activity within the first incremental step causing a small oil spill and exposing beluga, fin, or humpback whales is sufficiently small as to be considered unlikely and even improbable. If exposure were to occur, due to the ephemeral nature of small, refined oil spills, NMFS does not expect detectable or deleterious responses from whales.

Pinnipeds (Western DPS Steller Sea Lion)

In the event of a small oil spill, Steller sea lions could be briefly exposed depending on habitat use, densities, season, and various spill characteristics. If spills were to occur in the winter, floating sea ice reduces wave action and surface exchange thus delaying the weathering and dispersion of oil and increasing the level and duration of exposure to pinnipeds. It also reduces evaporation of volatile hydrocarbons, lessening the acute levels of toxins in the air but lengthening the period of exposure (Engelhardt 1987).

Sea lions exposed to oil spills may become contaminated with PAHs through inhalation, dermal contact and absorption, direct ingestion, or by ingestion of contaminated prey (Albers and Loughlin 2003). After the Exxon Valdez oil spill, Calkins et al. (1994) recovered 12 Steller sea lion carcasses from the beaches of Prince William Sound and collected 16 additional Steller sea lions from haulout sites in the vicinity of Prince William Sound, the Kenai coast, and the Barren Islands. The highest levels of PAHs were in animals found dead following the oil spill in PWS. Furthermore, sea lion bile samples collected seven months after the spill had levels of PAH metabolites consistent with exposure to PAH compounds (Calkins et al. 1994b). However, histological examinations found no lesions that could be attributed to hydrocarbon contamination and, hence, no evidence of damage due to oil toxicity (Calkins et al. 1994b).

Surface contact with petroleum hydrocarbons, particularly the low-molecular-weight fractions, to seals can cause temporary damage of the mucous membranes and eyes (Davis et al. 1960) or epidermis (Walsh et al. 1974, Hansbrough et al. 1985, St. Aubin 1988). Researchers have suggested that pups of ice-associated seals may be particularly vulnerable to fouling of their dense lanugo coat (Geraci and St. Aubin 1990b, Jenssen 1996). Though bearded seal pups exhibit some prenatal molting, they are generally not fully molted at birth, and thus would be particularly prone to physical impacts of contacting oil. Adults, juveniles, and weaned young of the year rely on blubber for insulation, so effects on their thermoregulation are expected to be minimal. Other acute effects of oil exposure that have been shown to reduce seal health and possibly survival include skin irritation, disorientation, lethargy, conjunctivitis, corneal ulcers, and liver lesions. Direct ingestion of oil, ingestion of contaminated prey, or inhalation of hydrocarbon vapors can cause serious health effects including death (Geraci and Smith 1976b, Geraci and St. Aubin 1990b). However, for small spills there is anticipated to be a rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh refined oil which limits potential exposure of seals to prolonged inhalation of toxic fumes

Based on the localized nature of small oil spills, the relatively rapid weathering expected for <1,000 bbl of oil, the small number of refueling activities in the proposed action, and the safe guards in place to avoid and minimize oil spills, we conclude that the probability of a BOEM/BSEE authorized activity within the first incremental step causing a small oil spill and exposing western DPS Steller sea lions is sufficiently small as to be considered unlikely and even improbable. If exposure were to occur, due to the ephemeral nature of small, refined oil spills, NMFS does not expect detectable or deleterious responses from Steller sea lions.

Designated Critical Habitat for Cook Inlet Beluga

The first and second essential features of Cook Inlet beluga critical habitat are focused on prey resources.[32] These PBFs may be adversely affected by oil spills. A spill in Cook Inlet could affect fish through many pathways, including adsorption to the fishes' outer body, respiration through gills, ingestion, and absorption of dissolved fractions into cells through direct contact. The severity of effects to fish would depend on several factors including the type of oil/gas mixture, the thickness of the oil, the duration of exposure, the season of year, and the life stage of the fish. Consumption of contaminated prey and the reduction or mortality of local forage fish populations could create periods whereby some prey would not be available for an undetermined time period. The fish populations in Cook Inlet preyed on by beluga whales are vulnerable to oil contamination and subsequent ingestion by beluga whales. Oil components could be consumed by beluga whales feeding on prey anywhere in the contaminated water column to the seafloor. Impacts to the distribution and abundance of prey, if they occurred, could influence seasonal distribution and habitat use by beluga whales (BOEM 2017b).

A small crude oil spill or condensate spill during open water would introduce hydrocarbon contaminants of various weights into the surface water, causing temporary decreases in water quality and conditions for toxicity for fish at the surface. Groundfish such as Pacific cod and pollock (primary prey species) occur in deeper waters where oil residues seldom reach, and are less likely to be exposed. Pelagic fish such as salmon have a higher chance of being exposed. In addition, eggs and fry of some bentho-pelagic and demersal fish may suffer lethal and sub-lethal effects from oil contact (BOEM 2016a). Fish with early life stages that occur at the surface and larvae would be particularly affected. Lighter weight hydrocarbon fractions (such as condensates) would volatilize more rapidly than heavier hydrocarbon fractions. Lighter weight fractions, however, would cause greater acute toxicity conditions for fish with early life stages that occur on the surface. During ice season, small crude oil and condensate spills could occur and cause fish to disperse from an area of ice used for feeding and shelter, or cause acute toxicity to weak-swimming or non-swimming early life stages at the surface (BOEM 2015b).

[32] PBF 1: Intertidal and subtidal waters of Cook Inlet with depths <30 feet (9m) (MLLW) and within five miles (8 km) of high and medium flow anadromous fish streams; PBF 2: Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole (50 CFR §226.220(c)).

However, due to the ephemeral nature of small, refined oil spills, NMFS does not expect detectable effects to Cook Inlet beluga critical habitat associated with accidental discharges that may occur during the first incremental step of the proposed action.

Designated Critical Habitat for Steller Sea Lion

During the Exxon Valdez spill Steller sea lions (Calkins et al. 1994b) were sighted swimming in or near oil slicks; oil was seen near numerous haul-out sites; and oil fouled the rookeries at Seal Rocks and Sugarloaf Island. Insignificant amounts of oil were seen at each site during pup counts in late June 1989, but none were seen in 1990. Critical habitat for Steller sea lions, including numerous haul-outs, a major rookery (Sugarloaf), and the aquatic foraging area throughout Shelikof Strait, all of which are within designated critical habitat per 50 CFR §226.202, could be contacted by a VLOS (see Section 6.2.6 for additional discussion). In addition, effects from very large oil spills that may occur during future incremental steps may extend beyond the action area for the first incremental step. However, small spills are not anticipated to occur within designated critical habitat as the blocks in LS 244 do not overlap with, and therefore no leases occur within, designated critical habitat, and small spills of refined products are expected to evaporate, weather, and disperse prior to reaching critical habitat. Small spills during the first incremental step are not expected to be in the form of crude oil, but rather refined petroleum products used in the execution of the first incremental step. These typically more volatile products are anticipated to evaporate within 24 hours. Although not expected, small spills of crude oil would persist longer in the environment and could cause greater impacts than spills of refined products (BOEM 2016a).

Similar to Cook Inlet beluga whales, small spills may impact prey resources for Steller sea lions in and around critical habitat. The decline in Steller sea lions has been linked to reductions in prey biomass and quality, resulting in nutritional stress that subsequently decreased vital rates (Kucey and Trites, 2006). Depending on the extent of the reduction in quantity and quality of prey species, the consequences of such a loss in the prey base could include decreased rates of reproduction or survivorship by reducing individual condition or fitness, or displacement from their habitats due to loss of prey availability (BOEM 2016a). However, this is not anticipated for isolated small spills during the first incremental step. While a small oil spill could cause minor effects to fish and shellfish, it is unlikely to have a measureable effect on local populations of fish and shellfish and in turn is unlikely to have a measurable effect on designated critical habitat. In addition, the implementation of mitigation measures such as Oil Spill Response Plans would be implemented to reduce the occurrence and volume of accidental spills (BOEM 2016a).

6.1.4.7 Responses to Oil Spill Drill Activities

During spill drills, whales and pinnipeds could be exposed to harassment levels of noise from vessels and increased risk of ship strike. Whales and pinnipeds are vulnerable to entanglement with underwater lines and could be injured or killed if they become badly entangled in underwater response equipment (e.g., boom lines or anchoring systems), particularly if the equipment is left unattended. However, exposures would be reduced by implementing mitigation measures identified in the OSRPs and through consultation with NMFS (e.g., having observers on vessels, minimizing boom installation, and minimizing in water time). In addition, oil spill drills are infrequent, of short duration (<8 hrs), and include standard mitigation measures (BOEM 2016a).

6.2 Anticipated Effects of Future Incremental Steps

While the proposed action is focused on exploration activities, this consultation also considers potential effects of future incremental steps through the endpoint of decommissioning. Future incremental steps consider the hypothetical E&D scenario, followed by the decommissioning of all of these activities (years 6-40) (Table 6).

Development and production logically flow if a leaseholder finds an economically-developable field. Under the E&D scenario, field development would occur between years 6 and nine, after which production would take place until the 34th year for oil and 39th year for gas (Table 6). Decommissioning would commence after oil and gas reserves at a given platform are depleted, and income from production no longer pays operating expenses. To comply with BSEE regulations (30 CFR §250.1710—wells, 30 CFR §250.1716—wellheads/casings, and 30 CFR §250.1725—platforms and other facilities), lessees are required to remove all seafloor obstructions from their leases within one year of lease termination or relinquishment (30 CFR §§250.1740-250.1743). BOEM and BSEE estimate that decommissioning activities would begin in the 35th year and continue through the 40th year (BOEM 2016a) (Table 6).

This schedule is ambitious and assumes no regulatory or scheduling delays and assumes immediate movement from exploration to development. The assumptions help ensure the potential impacts of future incremental steps will not be underestimated. However, the development of a prospect in the leased area would be determined by the lessee and could be affected by any delay.

BOEM does not anticipate additional seismic operations during future incremental steps (BOEM 2016a). Effects associated with seismic exploration operations under the first incremental step were analyzed under Sections 6.1.3.1 and 6.1.4.1.

Information on the specific number, location, timing, frequency, and intensity of subsequent projects is unknown at this time, so the effects from, and any incidental take resulting from, those future projects to be authorized, funded, or carried out under the program will be addressed in separate ESA section 7 consultations. In terms of future projects, (1) the subsequent authorization of geological and geophysical exploration permits, ancillary activities, exploration plans, permits to drill, and development and production plans may affect listed species and may require project-specific consultation associated with the issuance of Marine Mammal Protection Act Incidental Harassment Authorizations or Letters of Authorization; (2) if commercially recoverable reserves are found and are proposed for development, BOEM and BSEE may be required to initiate consultation on future incremental steps associated with development, production, and decommissioning activities that affect listed species.

6.2.1 Anticipated Effects from Vessel and Aircraft Traffic

Vessel and aircraft traffic could be increased from the exploration phase levels in order to access and support construction of production facilities in the action area. In addition, the duration and frequency of these activities may substantially increase as a production facility may be in operation year round for decades versus the relatively short duration and short season of exploration activities. However, once exploration and development activities are complete, aircraft and vessel traffic are expected to decrease.

BOEM assumes up to 76 wells may be drilled over the course of future incremental steps with vessels present 30-60 days per each well. This results in vessels operating for 2,280 to 4,560 days on LS 244 and throughout the action area in association with drilling operations.

6.2.1.1 Effects to Listed Species

While the range of effects to whales, pinnipeds, and designated critical habitats associated with vessel and aircraft are anticipated to be similar to those described during the first incremental step (see Sections 6.1.3.3 and 6.1.4.3), the intensity of those activities is anticipated to increase during the development and production phases. The duration and intensity of such activities likely would be years longer than exploration activities and may occur year round. As an example, noise from production platforms and associated vessels and aircraft traffic would occur for decades (BOEM 2017b).

There may be an increased risk of vessel strike due to the increased traffic. Vessel collisions with whales often lead to the death of the whale that was struck. However, most Cook Inlet beluga whales would be in upper Cook Inlet during the majority of vessel operations in the summer, lowering their chances of encounter. In addition, pinnipeds may be startled by vessel or aircraft noise and flush into the water. Over time sea lions may habituate to these continuous noise sources. However, in order to determine if habituation is occurring over time, long-term sequential measurements of responses by individuals to controlled stimuli are needed (Nisbet 2000, Bejder et al. 2009). Vessel and aircraft traffic is anticipated to decrease once exploration and development activities are complete, and platforms and pipelines have been installed (BOEM 2017b).

Standard mitigation measures would help avoid or minimize adverse effects to listed species. Timing stipulations would likely avoid adverse effects to newborn sea lion pups, particularly when nursing and molting, and reduce potential overlap with Cook Inlet beluga use of critical habitat in the lower inlet. BOEM does not anticipate any of the three potential production platforms would be installed within Cook Inlet beluga critical habitat (BOEM 2017b). Prey species within these areas are likely to become habituated, or even attracted to, presence of platform structures. Proposed pipelines may cross through Cook Inlet beluga whale critical habitat and may require multiple vessels for installation and maintenance. In addition, Port Graham may be used for a vessel staging area, and is located within Steller sea lion critical habitat. BOEM anticipates vessel and aircraft activities associated with future incremental steps would not appreciably diminish the value of critical habitat for both the survival and recovery of Cook Inlet beluga whales or Steller sea lions. Therefore, the future incremental steps of Lease Sale 244 are not likely to destroy or adversely modify either designated critical habitats. Activities associated with future incremental steps are likely to adversely affect listed species and may increase risk of strike and noise harassment (BOEM 2017b).

6.2.2 Anticipated Effects from Offshore Facility Construction and Operations

Production platforms and new subsea pipelines are the largest components that would need to be constructed to support getting product to existing infrastructure. BOEM anticipates this would include 2-3 platforms and ~200 mi pipeline installation[33] (see Section 2.4.1). Construction of the platforms may occur year round, and pipeline installation may occur from May through September (BOEM 2017b).

Under the E&D scenario, development would begin in the 6th year with installation of oil and gas pipelines through the 9th year. Subsea pipeline construction would mostly likely be on the Kenai Peninsula between Homer and Nikiski, and the site of the first production platform. The second and third platforms would have pipelines linking them to the initial platform. BOEM and BSEE estimate that 85 mi of subsea oil pipeline and 115 miles of subsea gas pipeline would ultimately be laid for development and production.

Noise from activities such as pile-driving, dredging, or equipment operation, would add to the existing noise level at the construction locations. Excavation and pipeline placement are slow moving operations and a relatively stationary sound source. Platform construction would produce lower energy localized noise from equipment operation, generators, etc. The sounds from these activities would not be likely to travel as far as sound from 2D/3D or geohazard site clearance seismic surveys. Similarly, pipeline construction would involve a slow-moving sound source that would have a localized, low energy noise footprint that is smaller than 2D/3D or geohazard site clearance seismic surveys (BOEM 2015a).

The loudest impulsive noise associated with production platform construction would be impact pile-driving. During Buccaneer's 2013 exploration drilling program in Cook Inlet Illingworth and Rodkin (2014) measured sound levels produced by the impact hammer Delmag D62-22 for 30-inch pile installation at their Southern Cross lease in Cook Inlet. The measured level was 190 dB re 1 μPa at 55 m. Using practical spreading (15 Log R), the extrapolated distance to the 120 dB re 1 μPa rms threshold was approximately 5,500 m. Due to ice characteristics, production platforms in Cook Inlet may require larger, or more, pilings to anchor each platform to the sea floor, or may use different hammer types and or models. Depending on project specifics, pile-driving sound propagation characteristics could change.

Pommerenck and Reyff (2016) determined that the distance to the 120 dB re 1 μPa (rms) isopleth for continuous noise was 5.35 km (3.32 mi) when the *Ile de Brehat* was pulling the sea plow near Nome. Trenching activities in Cook Inlet may produce similar propagation distances, but sound source verification would be needed to confirm propagation estimates.

Tug maneuvering near the Port of Anchorage recorded maximum sound pressure levels of 168.3 dB re 1 μPa (rms) at 1 meter during tug pushing activities (Blackwell and Greene Jr 2003). This noise level was increased to 178.9 dB re 1 μPa when thrusters were additionally operated during docking maneuvers (Blackwell and Greene Jr 2003). Using this source level and practical spreading model (15 log (R), results in an 8.45 km (5.25 mi) radius to 120 dB isopleth.

[33] Oil pipeline may total 60-85 miles in length in addition to gas pipelines totaling 60-115 miles in length (BOEM 2017b). The maximum estimated offshore gas pipeline length differs from the maximum extent estimated for the offshore oil pipelines because the E&D Scenario considers the possible development of a gas-only field that is farther from the potential shore based locations (BOEM 2017b).

The location, timing, and specific actions have not been determined and would be evaluated as development plans are submitted.

6.2.2.1 Effects to Listed Species

The effects to listed species and designated critical habitats are anticipated to be similar to those discussed for the first incremental step (see Sections 6.1.3.1 and 6.1.4.2). However the intensity and duration of construction activities is anticipated to be much higher during future incremental steps, and pipeline installation and platforms would be new sources of noise.

Listed whales would be expected to display variable responses to construction activity (ranging from no response to avoidance). Some whales may alter their movements away from or around a source of noise that bothered them. Beluga whales do not seem to travel more than a few kilometers in response to a single disturbance, and behavioral changes are temporary.

NMFS categorizes Cook Inlet beluga whales in the mid-frequency cetacean functional hearing group, with an applied frequency range between 150 Hz and 160 kHz (NMFS 2016f). NMFS categorizes Western North Pacific DPS and Mexico DPS humpback whales and fin whales in the low-frequency cetacean functional hearing group, with an applied frequency range between 7 Hz and 35 kHz (NMFS 2016f). The hearing ranges are anticipated to overlap with the 100 Hz–2 kHz frequency noise range produced by pile driving. However, sound source verification would most likely be required to confirm source levels and sound propagation distances to the various isopleths in Cook Inlet.

Pile-driving is anticipated to occur during the open water season and may overlap with listed whales. With audible noise levels slightly above those of ambient noise within a few kilometer of pile-driving activity, the effects of pile driving may include behavioral responses such as slight shifts in individual migration trajectories to avoid approaching the noises and activity. No PTS, TTS, or other physiological responses should occur from pile-driving or other construction activities, dredging, or pipeline construction because of the implementation of standard mitigation measures.

Construction of production facilities would likely take place year round (until complete). Some activities could be scheduled to take place during the winter when some listed whales are largely absent from Cook Inlet (e.g., humpback whales). However, fall or winter construction may increase potential overlap with Cook Inlet beluga whales, and fin whales are known to occur year round.

6.2.3 Anticipated Effects from Development and Production Drilling Operations

Future incremental steps only include production and service wells. All exploration and delineation wells were analyzed as part of the first incremental step.

All production well and service well drilling would be conducted from a production platform. An estimated annual maximum of six wells could be drilled by each production platform (i.e., 18 wells total per year for three platforms). However, not all platforms are anticipated to come on line at the same time. While each platform would contain up to 24 well slots, only 55-76 production and service wells are anticipated to be drilled during future incremental steps. Out of the total wells that may be drilled, 10-12 of these are anticipated to be service well. Production and service well drilling is expected to begin in the 7th year and continue through the 13th year (Table 6) (BOEM 2017b).

6.2.3.1 Effects to Listed Species

Drilling operations generate continuous underwater sounds that could affect listed species and designated critical habitat in the same ways as previously discussed for exploration drilling (Section 6.1.4.3). However drilling activities likely would occur year round until production wells are completed, which could increase the duration and intensity of effects associated with drilling operations in the future. As an example, instead of a maximum of up to 6 wells being drilled per year during the first incremental step exploration phase of the proposed action, a maximum of 18 wells may be drilled per year during future incremental steps (six wells per platform) (BOEM 2017b). The use of thrusters to position jack-up rigs for exploratory drilling can significantly elevate noise levels (Nedwell and Edwards 2004, BOEM 2016a, Denes et al. 2016). If production platform installation also requires the use of thrusters, noise levels may be temporarily elevated beyond what is expected from drilling alone. However, specific development proposals would be further assessed and consulted upon incrementally for development as specific actions and action areas become known.

A total of three production platforms would be installed, and a maximum of 18 production and service wells would be drilled in a single year (but not necessarily during the same season). Sound source verification measurements were conducted in Cook Inlet for drilling and mud pumping activities on the jack-up rig *Yost* in 2016 in Cook Inlet (Denes and Austin 2016). These measurements indicated source levels for drilling were 158 dB re 1 µPa rms at 1m. The Level B 120 dB re 1 µPa threshold distance was estimated at 330 meters for drilling and 172 meters for mud pumping (Denes and Austin 2016). However, underwater measurements from *Phillips A* oil platform in Cook Inlet in 2002 indicated the 120 dB threshold at a radius of 1.2 km (Blackwell and Greene Jr 2003). Assuming the decibel and frequency levels between the jack-up rig and production platform in Cook Inlet are similar, the radii for effects should extend to 330 m or less from each production platform.

Not all platforms would be drilling simultaneously; however, the noise production from drilling 76 wells from three platforms would result in multiple wells per platform during the peak of drilling activity. The noise footprint from this level of drilling would amount to a 330 m to 1.2 km zone surrounding each production platform where manmade noise might exceed the harassment threshold for marine mammals for continuous noise sources, at low frequencies averaging 10-500 Hz (BOEM 2016a), which is within the bottom range of the auditory bandwidth for low-frequency cetaceans (7 Hz–35 kHz), mid-frequency cetaceans (150 Hz- 160 kHz), and otariids (60 Hz – 39 kHz) (BOEM 2016a, NMFS 2016f). It is anticipated that whales would continue moving across Cook Inlet as needed, diverting around locations where drilling is occurring by 330 m to 1.2 km. Drilling from production platforms produces much less noise than drilling from drillships, so noise effects on listed species would be reduced and restricted to the immediate vicinity of the platform (BOEM 2015a). Once drilling is completed, listed species should tolerate the presence of production wells potentially passing near areas of active production platforms with minimal response (McDonald et al. 2006, Aerts and Richardson 2008). However, in order to determine if habituation is occurring over time, long-term sequential measurements of responses by individuals to controlled stimuli are needed (Nisbet 2000, Bejder et al. 2009).

Drilling operations are likely to displace some primary prey resources and listed species. We anticipate responses of prey species and listed resources to production and service well drilling will be similar to what was described in Section 6.1.4.2. Off the coast of Barrow, Alaska, Richardson et al. (1991) played back recordings of drilling noise and reported “overt reactions” by beluga whales; these reactions included: slowing down, milling, and/or reversing direction. However, Richardson et al. (1995a) reported beluga whales outside of Cook Inlet near drill-sites and artificial islands showed little to no disturbance to the associated noise. Blackwell and Greene (2003), suggest that “belugas in industrialized areas have to a large extent habituated to noises from ships and industrial activities, when compared to animals living in remote locations such as the high Arctic.”

The location, timing, and specific actions have not been determined and would be evaluated as development and production plans are submitted to BOEM and BSEE. Individual whales and pinnipeds likely would avoid activities that bothered them; the distances vary according to the individual and site-specific conditions (activity type, duration, and timing, etc.). These activities, however, would be subject to mitigation measures developed in subsequent ESA section 7 consultations that would help avoid adverse effects on whales, pinnipeds, and designated critical habitat.

Development and production drilling operations associated with future incremental steps are likely to adversely affect listed species with active drilling occurring over seven years and the platforms being in place for decades (BOEM 2017b). BOEM anticipates development and production drilling operations would not appreciably diminish the value of critical habitat for both the survival and recovery of Cook Inlet beluga whales or Steller sea lions.

6.2.4 Anticipated Effects from Seafloor Disturbance

Habitat alteration and seafloor disturbance may occur from drilling operations, pipeline installation, and geotechnical surveys during future incremental steps. The effects to listed species and designated critical habitat are anticipated to be similar to those discussed for the first incremental step (Section 6.1.3.5). However the intensity and duration of drilling activities are anticipated to be much higher during future incremental steps, and pipeline installation would be a new source of seafloor disturbance.

As described above, BOEM anticipates 76 wells may be drilled in the action area during future incremental steps (Table 6). No discharges of drilling fluids and cutting are anticipated to occur during development and production. However, authorized discharges from OCS facilities during future incremental steps are expected to include deck drainage, sanitary and domestic waste, desalination unit brine, cooling water, bilge and ballast water, and other miscellaneous discharges. The production fluids (oil, gas, and water) would be gathered on the platforms where gas and produced water would be separated and gas and water reinjected into the reservoir using service wells. During the later gas sales phase, water would continue to be reinjected (BOEM 2017b).

A total of three production platforms may be installed during future incremental steps. These platforms would be in place for decades (Years 7-39). It is assumed that each production platform will be a steel-caisson platform. Total area of sediment disturbed by a steel-caisson platform will depend on platform design, however, BOEM estimates each platform may disturb approximately 1.5 ha (3.7 ac) of seafloor (BOEM 2017b). No additional surface disturbance from drilling development wells from the platform is expected. A small portion of the LS 244 area overlaps with Cook Inlet beluga whale Area 2 critical habitat, so it is possible that a platform would be located within critical habitat designated for Cook Inlet beluga whales.

BOEM assumes two offshore oil pipelines and three offshore gas pipelines will be installed with a landfall probably on the Kenai Peninsula between Homer and Nikiski (see Section 2.4.1). Pipeline routes will depend on where a commercial discovery is made, although the likely landfalls are on the east side of Cook Inlet. Additional subsea pipelines would be constructed to connect the other platforms to the hub platform. Pipeline construction is expected to occur between May and September (BOEM 2016a). Because a small portion of the LS 244 area, where platforms may be located, overlaps with Cook Inlet beluga whale Area 2 critical habitat, pipelines may be constructed through critical habitat designed for Cook Inlet beluga whales.

If possible, all pipelines will be trenched at least 1m below the mudline. If trenching is not possible due to unsuitable sediments, anchors or concrete would likely be used to provide stability to the pipeline to resist strong tidal movements. It is estimated that placement disturbs between 0.5 and 1 ha (1.25 and 2.5 ac) of seafloor per kilometer of pipeline, with the uncertainty depending on whether trenching is required (Cranswick 2001). BOEM estimated that the total length of the offshore oil pipelines will range 96 to 137 km (60 to 85 mi), and the total length of the offshore gas pipelines will range from 96 to 185 km (60 to 115 mi), depending on the actual platform and landfall locations. For the total potential pipeline length of 322 km (200 mi), it is estimated that 161 to 322 ha (398 to 796 ac) of seafloor could be disturbed, depending on the amount of trenched and buried pipe. It is not expected that pipelines will be removed at the end of their serviceable life; rather, they will be decommissioned and buried in sediment. This practice prevents the additional disturbance to sediments and benthic communities which would occur if pipelines were removed (BOEM 2016a). However, maintenance and repair activities may periodically be required.

6.2.4.1 Effects to Listed Species

Habitat alterations can occur due to disturbance of the benthic surface resulting from the volume and physical nature of materials (mud, sand, cobblestone, etc.) that are displaced by the actions of oil and gas discovery, development, and decommissioning activities. These activities would include anchoring of vessels and platforms, construction of infrastructure such as pipelines, well drilling activities, and any similar activities that would disturb benthic surfaces. The disturbance of these surfaces and their effects are further defined by dispersal of materials through the water column (density of particles and residence time in the water column), and subsequent deposition on the benthic surface (area and depth of coverage of the benthic surface by displaced materials). Effects would include the temporary disruption of pelagic habitat by way of turbidity caused by suspended material, loss of benthic habitat, and injury or mortality of the benthos. Models of tidal currents in Cook Inlet predict current speeds range from approximately 2 to 4 m/s (approximately 3.8 to 7.7 kn), generally flowing in a north-south direction. Based on this velocity and flow, suspended sediments would be removed from the area of impact almost immediately, reducing the level of impact on benthic fish and shellfish (BOEM 2016a).

The platforms and surface-laid pipelines would create hard substrate, and the area on and immediately around the platform would have habitat functions and biological communities very different from these in the pre-construction period (Gallaway and Lewbel 1982). Algae and sessile invertebrates (e.g., mussels, barnacles, bryozoans) would attach to the platform and would in turn attract hard bottom organisms (Stachowitsch et al. 2002). The ecological function and value of artificial reef habitat is relative as some species may benefit while others do not (Daigle 2011). In addition, sediment grain size and the biogeochemical processes around the platform could be altered by the flux of biogenic material from the platform to the seafloor. For example, an increase in shell material and organic matter likely would result along with a transition to benthic species adapted to these conditions (Montagna et al. 2002). The replacement of soft sediment with artificial reef (e.g., platform legs, pipelines) would exist during the production phase, as all infrastructure would be removed or buried during decommissioning. In soft sediments of the deep sea, communities may form on mooring structures, but colonization likely would be slow, and mooring structures would be completely removed during decommissioning, so any impacts would be temporary (BOEM 2016a).

A literature review of studies of benthic community change around platforms suggests that benthic communities may return to baseline conditions within one year after the cessation of drilling (Ellis et al. 2012). Disturbed sediments with a greater proportion of sand to mud may fill in with fine silty material, altering grain size and potentially inhibiting the colonization of species that existed in the area prior to the disturbance (BOEM 2016a).

Proposed pipelines may cross through Cook Inlet beluga whale and, depending on where pipelines make landfall, through Steller sea lion critical habitat. This could result in temporary displacement of prey species from seafloor disturbance during trenching operations, and noise. Once pipelines are in place, there would likely be no residual effects on behavior or habitat (BOEM 2017b) unless maintenance operations were needed.

Indirect effects to listed species and designated critical habitat are primarily related to prey. Whales and sea lions may forage on benthic invertebrates which may be buried resulting in prey mortality during operations that disturb the seafloor. Turbidity could affect the prey species and possibly the ability of marine mammals to locate prey in the immediate area of the drilling. However, this is anticipated to be minor due to the tidal currents in the area. Trenching and pipe laying operations are anticipated to occur during the spring/summer season and should avoid spawning and migration timing for longfin smelt, Pacific herring, Pacific sand lance, eulachon, capelin, and numerous groundfish species. However, adult salmonid species may be impacted as they migrate through Cook Inlet to natal streams (BOEM 2016a).

Any mortalities or impacts to prey that might occur as a result of the proposed action are immaterial compared to the naturally occurring high reproductive and mortality rates. In addition, disturbed areas, depending on substrate types, community composition, and ocean current speed and direction, would begin the process of recolonization after deposition has completed following the benthic disturbance (Conlan and Kvitek 2005) (BOEM 2016a). Invertebrate species important to large mammalian benthic foragers, such as bivalves, would likely reach sizes readily utilized by foraging mammals at approximately 7-9 or more years depending upon substrate classification, depth, and water temperature (BOEM 2015a). Other benthic foragers such as crabs, fish, and pelagic bird species typically utilize smaller organisms such as amphipods, copepods, shrimp, nematodes, and polychaetes. These are among the first to recolonize taking generally less than a year for establishment in new locations (Trannum et al. 2011). Disturbed fish habitats are likely to be recolonized within 3 years. Pelagic fishes may re-inhabit the pipeline corridor within hours to days after construction operations cease and the trenched areas have filled back in with material (BOEM 2016a).

Impacts to fish and shellfish from these development and production activities would be similar to impacts from seafloor disturbance discussed previously that could occur during exploration activities. Decommissioning activities that would disturb the seafloor include plugging wells, removal of seafloor equipment, decommissioning of offshore pipelines, and removal of platforms. Impacts to fish and shellfish from decommissioning activities would be similar to impacts discussed for and the development phase (BOEM 2016a).

Based on the above, we would not expect any population level effects to listed marine mammals, either directly through contact or indirectly by affecting prey species from substrate alteration. Any effects would be localized primarily around the drilling platform or pipeline because of the rapid dilution/deposition of materials and the recolonization of prey species (BOEM 2016a).

Overall, seafloor disturbance and habitat alteration could have a few highly localized, short-term effects to a few marine mammals. Potential effects from seafloor disturbance are likely to limit the foraging quality of the disturbed area during drilling, and possibly for a few years afterward in some locations. These effects should be consistent and less than what has been occurring throughout Cook Inlet since the first production platform was created in the 1960s. Seafloor disturbance would occur during development, production, and decommissioning activities; however, there should be no lingering effect on the area once wells have been plugged and abandoned, platforms removed, and subsea pipelines are decommissioned.

6.2.5 Anticipated Effects from Trash and Debris

Operations that may occur under future incremental steps will generate trash comprised of paper, plastic, wood, glass, and metal mostly from galley and offshore food service operations. A substantial amount of waste products could be generated from drilling activities over the duration development, production, and decommissioning activities. The possibility exists that trash and debris could be released into the marine environment, and the intensity and duration of this release may be increased in the future due to the increase in activities in general. While this type of trash and debris discharge is illegal, it can pose significant risks to marine mammals, and is anticipated to be more common and widespread than accidental or illegal oil discharges.

The effects to baleen whales and pinnipeds associated with trash and debris during future incremental steps (years 6-40) are anticipated to be similar to those described for the first incremental step of exploration (see Section 6.1.3.6) (BOEM 2017b).

In addition to MARPOL requirements, all vessel operators, employees, and contractors actively engaged in oil and gas operations should receive instruction on marine trash and debris awareness elimination as described in Section 2.5. BOEM will not require operators, employees, and contractors to undergo formal training or to post placards. However, the operator will be required to ensure that its employees and contractors are made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment

Because operators must comply with federal regulations and BOEM's trash and debris guidance, the amount of trash and debris occurring within the action area is expected to be minimal and distributed over a wide area, likely resulting in an undetectable effect. The exception to this would be accidental discharge of plastic or fiber packing bands and other non-biodegradable closed loops, which could cause entanglement of Steller sea lions and, to a lesser extent, beluga whales.

6.2.6 Anticipated Effects from Oil Spills and Gas Releases

This analysis is focused on the probability of an unauthorized discharge of oil and gas, and the potential impacts associated with exposure of ESA-listed marine mammals and designated critical habitat under NMFS's authority, to small, large, and VLOS events during development, production, and decommissioning activities associated with future incremental steps in the action area.

The effects to listed species and designated critical habitat are anticipated to be similar to those discussed for the first incremental step (see Sections 6.1.3.9 and 6.1.4.6). However the intensity and duration of drilling activities is anticipated to be much higher during future incremental steps, and pipeline installation and production facilities would be new sources of potential spills.

Approach to Estimating Exposures to Oil and Gas Spill
Estimating oil spill occurrence and potential effects on marine mammals is an exercise in probability. Uncertainty exists regarding the location, number, and size of small, large, and very large oil spills, and the wind, ice, and other environmental conditions that could occur at the time of a spill. Additional uncertainty exists because it is difficult to predict conditions and events up to 40 years into the future. The following sections will go into the probabilities of various sized oil spills occurring in the area of LS 244 during years 6-40 of future incremental steps, and the assumptions behind those analyses.

Small Oil Spills
For the purposes of analysis, BOEM and BSEE estimate that approximately 450 small spills (<1,000 bbl) totaling ~300 bbl could occur during future incremental steps (years 6-40).

Small spills of both refined oils and crude[34] or condensate oils could occur during future incremental steps. The estimated total and volumes of small refined oil spills resulting from future incremental step activities are presented in Table 23. BOEM and BSEE anticipate that the majority of these spills would be <1bbl (3 gallons) on average but assume that 16 spills of 1 to <50 bbl, and up to two spills of 50 to <500 bbl, could occur. No small spills greater than 500 bbl are anticipated during future incremental steps (BOEM 2017b).

[34] BOEM chose a medium crude oil for purposes of spill analysis because it is a crude oil that falls within 20-25° API oils estimated to occur within the Lease Sale 244 action area (BOEM 2016a).

Table 23. BOEM's estimated total number of refined and crude or liquid gas condensate oil spills during the future incremental steps of the proposed action (years 6-40) (BOEM 2016a, 2017b).

ESA Step	Phase	Activity	Source of Spill	Number of Spill(s)[1]		Size of Spill(s) (in bbl)	Estimated Total Spill Volume	Frequency of Occurrence
Future Incremental Steps	Development, Production and Decommissioning	**Small Spills (Crude, Condensate, or Diesel and other Refined Products)**						
		Development Plan Activities (Development, Production, Decommissioning)	Offshore and/or Onshore Operational Spills from All Sources	~450[1] Total			~300[1] bbl	>99.5% of a small spill
				<1 bbl	432[1]	3 gallons	10 bbl	
				1-<50 bbl	16	3 bbl	48 bbl	
				50-<500 bbl	2	126 bbl	252 bbl	
				500-<1,000 bbl	0	0 bbl	0 bbl	
		Large Spill or Gas Release (Crude, Condensate, Diesel or Refined, or Natural Gas)						
		Development Plan Activities (Production)	Onshore Pipeline, or Offshore Pipeline, or Offshore Platform/ Storage Tank/Well	0.24 Total NEPA and Biological Assessment analysis assumes up to 1 from either		2,500 bbl, or 1,700 bbl, or 5,100 bbl	2,500 bbl, or 1,700 bbl, or 5,100 bbl	78%[2] chance of no large spills occurring; 22% chance of one or more large spills over the entire life.
			Offshore Platform/Well	1 gas release		8 million ft^3	8 million ft^3	3.6 $x10^{-4}$ per well
		Very Large Oil Spills (Crude)						
		Development Plan Activities						Not estimated to occur $>10^{-4}$ to $<10^{-5}$

Note: [1] These numbers have been adjusted for rounding. [2] Estimated from a mean large spill number of 0.243.

Large Oil Spills

BOEM and BSEE's estimate of the likelihood of one or more large spills occurring during future incremental steps assumes there is a 100% chance that development(s) will occur and 215 million barrels (MMbbl) of crude oil and natural gas liquid condensate will be produced. A large spill could potentially come from five sources associated with OCS development plan operations: (1) onshore pipelines, (2) offshore pipelines, (3) offshore platforms, (4) storage tanks/wells, and (5) offshore gas platforms/wells. BOEM and BSEE reviewed those five sources and determined an OCS platform spill had the potential for the largest spill volumes, assuming all primary and secondary safeguards fail (BOEM 2017b).

BOEM and BSEE's large spill rates are based on the mean number of large spills per billion barrels of hydrocarbons produced or transported. This results in an estimate of less than one (0.24) large spill over the duration of future incremental steps (BOEM 2017b). BOEM and BSEE estimate that the percent chance of one or more large platform/pipeline spills occurring during future incremental steps is 22% (and thus a 78% chance of no large spills occurring). Finally, BOEM and BSEE estimated one gas release of up to 8 million cubic feet has a probability of 3.6 x 10^{-4} per well of occurring during future incremental steps.

At this time, pipelines are the preferred mode of petroleum transport (over tankers) in Cook Inlet, therefore, BOEM and BSEE did not consider the loss of a fully loaded tanker reasonably foreseeable.

To estimate the effects of a large oil spill resulting from future incremental steps, BOEM and BSEE estimated information regarding the general source(s) of a large oil spill (such as a pipeline, platform, or well), or gas release, the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. BOEM and BSEE also estimated the mean number of large spills or gas release and the chance of one or more large spills or gas release occurring over the full 40 years (BOEM 2017b).

The large spill-size assumptions BOEM and BSEE used are based on the reported spills in the Gulf of Mexico and Pacific OCS because no large spills have occurred on the Alaska OCS from oil and gas activities.[35] BOEM used the median OCS spill size as the likely large spill size (Anderson et al. 2012b) because it is the most probable size for that spill size category. The Gulf of Mexico and Pacific OCS data show that a large spill most likely would be from a pipeline or a platform. The median size of a crude oil spill ≥1,000 bbl from a pipeline on the OCS over the last 15 years in these other locations is 1,720 bbl, and the average is 2,771 bbl (Anderson et al. 2012b). The median spill size for a platform on the OCS over the entire record from 1964-2010 is 5,066 bbl, and the average is 395,500 bbl (Anderson et al. 2012b). Outliers, such as the DWH and Exxon spill volume, skew the average, and the average is not a useful statistical measure particularly for events that are not considered reasonably foreseeable or reasonably certain to occur. BOEM and BSEE relied on the Office of Pipeline Safety Research and Special Programs Administration records to determine the mean onshore pipeline spill size of 2,500 bbl (USDOT 2015a). For purposes of analysis BOEM/BSEE used the median spill size (rounded to the nearest hundred) as the likely large spill sizes (Table 22) (BOEM 2017b).

Large condensate and diesel fuel spills would evaporate and disperse, generally within 1–10 days depending on size of spill. A large crude oil spill, however, is estimated to persist much longer: after 1-30 days, approximately 10 to 24% respectively of its original volume would evaporate at both summer and winter temperatures. At the average wind speeds over the LS 244 Action Area during summer, dispersion is slower than during winter in open water, ranging from 3-56% (BOEM 2016a). BOEM estimates that at higher wind speeds during winter (e.g., 15 m/s wind speed) three quarters of a large oil spill will be nearly removed from the sea surface within a day through evaporation and dispersion. However, dispersion would be significantly reduced during the winter in the presence of broken ice (BOEM 2017b).

A large crude oil spill from a platform (5,100 bbl) into open-water (April 1- October 31) would cover an estimated discontinuous area of 59 km^2 after 3 days and 1,159 km^2 after 30 days. A large crude oil spill from a platform on to the broken ice surface during November through March would cover an estimated discontinuous area of 58 km^2 after 3 days and 1,153 km^2 after 30 days (see Table A.1-4 in BOEM 2017b). A large crude oil spill from an offshore pipeline (1,700 bbl) during open-water would cover an estimated discontinuous area of 34 km^2 after 3 days and 662 km^2 after 30 days. A large offshore pipeline crude oil spill onto the broken ice surface during November through March would cover an estimated discontinuous area of 33 km^2 after 3 days, and 658 km^2 after 30 days (see Table A.1-5 in BOEM 2017b). Oiled ice that drifts

[35] The *Exxon Valdez* oil spill was a very large oil spill that occurred within Alaska state waters in 1989, spilling 260,000 bbl of crude oil from a grounded tanker. It was not considered in the large spill analysis because it is outside the size range for a large spill. To note, it did not occur within OCS waters or involve oil from the OCS.

and subsequently melts during open water would introduce oil into surface waters in new areas (BOEM 2015a).

Very Large Oil Spills

A very large oil spill (≥120,000 bbl) in Cook Inlet associated with the proposed action over a 40 year duration is considered a low-probability, high impact event. BOEM estimates that the risk of such an event occurring in Cook Inlet is between > 10^{-4} and > 10^{-5} per well drilled (Table 22) (BOEM 2017b). Although the risk of a VLOS is estimated to be very small, we analyze the potential effects of BOEM's hypothetical VLOS scenario in the sections below to consider the effects of this low-risk, high-impact event.

The VLOS scenario assumes a hypothetical spill of 120,000 bbl of oil. To analyze potential impacts of a VLOS scenario (BOEM 2016a, Appendix A), five phases are described from the initial event to long-term recovery. Within each phase are one or more components that may cause impacts to the environment (i.e., impact producing factors or stressors). Impacts by phase are described in terms of the oil spill itself and the activities occurring within each phase for response activities (e.g., increased vessel traffic; use of dispersants during spill response activities). This approach is consistent with that used in the Final Second Supplemental EIS for Lease Sale 193 (BOEM 2015b) and relevant only to the VLOS scenario, in which oil is hypothetically released at an average rate of 1,500 bbl per day for 80 days (BOEM 2016a).

No special OSRA run (an oil-spill trajectory model that BOEM uses) was conducted to estimate the percentage of trajectories contacting resources from a hypothetical future catastrophic blowout and moderate volume, long-duration flow resulting in a VLOS. For purposes of this VLOS analysis, the conditional probabilities were considered to represent the estimated percentage of trajectories contacting an ERA, land segment, grouped land segment, or boundary segment. For the purposes of analyzing potential impacts of a VLOS, the percentage of trajectories within 110 days during summer and winter were analyzed (BOEM 2016a).

Although extremely unlikely, very large spills (> 120,000 bbl) may result from OCS development and production operations involving platforms, pipelines, and/or support vessels. Incidents with the greatest potential for catastrophic consequences are losses of well control with uncontrolled releases of large volumes of oil, where primary and secondary barriers fail, the well does not bridge (bridging occurs when the wellbore collapses and seals the flow path), and the flow is of long duration.

In general, historical data show that loss of well control events resulting in oil spills are infrequent and that those resulting in very large oil spills are even rarer events (Anderson and LaBelle 2000, Bercha Group 2006, Anderson et al. 2012b, BOEM 2016a). The Norwegian SINTEF Offshore Blowout Database, which tracks worldwide offshore oil and gas blowouts, where risk-comparable drilling operations are analyzed, supports the same conclusion. Blowout frequency analyses of the SINTEF database suggest that the highest risk operations are associated with exploration drilling in high-pressure, high-temperature conditions. As the 2010 DWH event illustrated, there is a greater than zero risk of a very large spill occurring, likely causing catastrophic impacts (BOEM 2016a).

A fundamental challenge is to accurately describe this risk, especially since there have been relatively few large to very large oil spills that can serve as benchmarks. Prior to the DWH event, the three largest blowout spills on the OCS were 80,000 bbl, 65,000 bbl, and 53,000 bbl, and all occurred before 1971 (Anderson et al. 2012b). From 1964 to 2010 there were 283 well control incidents, 61 of which resulted in crude or condensate spills (drilling mud or gas releases not included) (Table 24). Excluding the DWH event, less than 2,000 bbl of crude or condensate were spilled from fewer than 50 well control incidents after 1971. During the 1971–2010 period, more than 41,800 wells were drilled on the OCS and almost 16 Bbbl of oil produced (BOEM 2016a).

Table 24. Loss of well control by region during OSC activities from 1964-2010 (BOEM 2012b).

Region	Exploration Wells	Development Wells	Loss of Well Control Events	Loss of Well Control with Oil Pollution Events
Alaska	84	6	0	0
Atlantic	51	0	0	0
Gulf of Mexico	16,889	29,733	278	59
Pacific	324	1,372	5	2
Total	17,348	31,111	283	61

Oil Weathering and Spill Trajectory Analyses
BOEM uses the SINTEF OWM to perform oil weathering simulations. The SINTEF OWM has been tested with results from three full-scale field trials of experimental oil spills (Daling and Strom 1999, Brandvik et al. 2010 as cited in BOEM (2016a)). For the Lease Sale 244 action area, BOEM assumes open water is April through November, and a winter spill could occur into open water or broken ice. BOEM assumes the spill starts at the surface or quickly rises to the surface in the shallow waters of the Lease Sale 244 action area. For open water, BOEM models the weathering of the spills as if they are instantaneous spills. For the broken ice spill scenario, BOEM models the entire spill volume as an instantaneous spill. Although different amounts of oil could melt out at different times, BOEM took the conservative approach, which was to assume all the oil was released at the same time (BOEM 2016a).

BOEM studies how and where large offshore spills move by using an oil-spill trajectory model, known as the OSRA model, which calculates the probability of oil-spill contact (conditional probabilities) and occurrence and contact (combined probabilities) to environmental resource areas (ERAs). In this approach, BOEM simulated large spills originating from one of six Launch Areas and four Pipeline Segments, hypothetical locations in the proposed Lease Sale 244 action area shown in the FEIS (BOEM 2016a). The locations are not meant to represent or suggest any particular development scenario or outcome. BOEM uses the results of more than 800,000 trajectory simulations to calculate conditional probabilities (the “estimated percent chance”) that a large spill from one of these areas would contact certain resources or shorelines in Cook Inlet and the surrounding region (BOEM 2017b).

Additional risk analyses will be conducted on a project specific basis. BOEM or BSEE will consider risk during the review of an operator's Exploration Plan, Development and Production Plan (or Development Operations Coordination Document), and/or Application for Permit to Drill.

Large and Very Large Gas Releases

BOEM estimates development and production activities on LS 244 may result in 517 billion cubic feet (Bcf) of natural gas over 34 years. In order to estimate natural gas release, they considered potential releases from the following sources (BOEM 2016a):

- Loss of well control (LOWC) escalating into a gas blowout at production platforms/wells
- Ruptured or leaking pipelines
- Onshore facilities

It is possible, though unlikely, that a 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% and the chance of a gas release occurring is 4% over the life of the Proposed Action (BOEM 2016a).

The record for Cook Inlet gas blowouts may not be complete, but is presented as the best available information based on newspaper accounts and other available information. No gas releases due to blowouts were identified in either the spill data or the newspaper accounts. A minimum of eight natural gas blowouts were recorded in Cook Inlet (Table 25).[36]

Table 25. Reports of Natural Gas Well Blowouts in Cook Inlet (BOEM 2016a).

Date Start Date End	Location	Company	Well Name	Well Type	Medium	Kill Method	Notes	Sources
1962	Onshore		Beluga River 212-35	Development	Natural Gas			ADN, 2008
6/10/-7/24/1962	Offshore Middle Ground Shoal	Pan American Petroleum Corp.	Cook Inlet State No. 1	Exploration	Natural Gas			ADN, 2008, AOGCC, 2010
8/23/-10/23/1963	Offshore Middle Ground Shoal	Pan American Petroleum Corporation	Cook Inlet State 17589 No. 1	Exploration	Natural Gas	Relief Well, No. 1-A	Burned	ADN, 2008
1965	Onshore		Moquawkie No 1.	Exploration	Natural Gas	--		ADN, 2008
2/11/-3/1967	Onshore	Marathon Oil Company	Beaver Creek No. 1	Development	Natural Gas	Bridged		ADN, 2008

[36] While not considered a blowout, Hilcorp recently experienced a natural gas leak from one of the subsea pipelines off Platform A in Cook Inlet in 2017. The initial estimated leak rate was between 225,000 and 325,000 cubic feet per day. The leak took nearly four months to complete repairs due to ice conditions (Hilcorp 2017). Additional information on this event can be found in Section 5.

5/23/-5/26/1985	Offshore	Union Oil Company	Grayling Platform	Development	Natural Gas, Water, Drilling Mud	Bridged		ADN, 2008
12/20/-12/28/1987	Offshore	Marathon Oil Company	Steelhead Platform Well M-26	Development	Natural Gas, Water, Coal, and Rocks	Relief Well Started, Bridged		ADN, 2008
9/28/-9/29/2008	Onshore	Aurora Gas	Moquawkie No. 4	Development	Natural Gas, Drilling Mud 11,000 gallons	Drilling Mud		ADEC, 2008; ADN, 2008

In year 7, infrastructure will have been installed, and sale of natural gas from LS244 is expected to begin. When this occurs, it is assumed that one well control incident of a single well on the facility could occur, releasing 8 million cubic feet of natural gas for one day (Table 23). 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 (BOEM 2016a).

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 x 10-5 per mile-year (MMS 2009). For a 115 mile offshore gas transmission pipeline system, over a 33 year production life, the estimated number of incidents is 0.09 offshore gas pipeline ruptures over the life of the gas sales. For onshore gas pipelines, the estimated spill rate for a generic DOT onshore gas transmission lines from 1994-2013 is 1.5 x 10-4 spill or release per pipeline mile per year (USDOT 2013a, b). For a 50 mile onshore pipeline, over a 33 year production life, the estimated number of significant incidents using DOT's estimated rate is 0.27 pipeline incidents over the life of the gas sales. Under DOT regulation, significant incidents are incidents that involve property damage of more than $50,000, injury, death, release of gas, or that are otherwise considered significant by the operator (BOEM 2016a).

If a major release of natural gas would occur, this would cause a sudden decrease in gas pressure within system pipelines, which in turn would automatically initiate procedures to close the valves on both ends of the ruptured segment of pipeline. Closure of the valves would effectively isolate the rupture and limit the amount of natural gas released into the environment. Given the daily flow rate and the estimated total number of valves, it is estimated that approximately 20 million cubic feet could be released within one pipe section between two valves (BOEM 2016a).

Gas Release Fate

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

In the event of a pipeline rupture, the leak detection system would close the pipeline isolation valves. Any release would be almost entirely vapor, rather than liquid. Winter temperatures could cause the butane and pentane components to initially remain in a liquid state. However, if any liquids formed, much of the volume would quickly evaporate due to the volatile nature of

NGLs. The consequences of an accidental spill of natural gas liquids as a result of a pipeline rupture could include fire and/or explosion of vapors from natural gas liquids.

The primary component of natural gas is methane, a colorless, odorless, and tasteless gas. It is not toxic in the atmosphere, but is classified as a simple asphyxiate, possessing an inhalation hazard. As with all hydrocarbon gases, if inhaled in high enough concentration, oxygen deficiency could occur and result in suffocation. The specific gravity of methane is 0.55 (Air = 1.0). Being lighter than ambient air, it has the tendency to rise and dissipate into the atmosphere, rather than settle into low areas. For this reason, natural gas leaks are assumed to rise and disperse (BOEM 2016a).

6.2.6.1 Effects to Whales (Beluga, Fin, and Humpback whales)

The primary potential effects to listed marine mammals from accidental oil spills include: (1) fouling of individuals (including fur and baleen), (2) ingestion/inhalation of oil, (3) habitat/prey degradation, (4) disruption of migration, and (5) oiling of skin, eyes, and conjunctive membranes (BOEM 2016a). Disruption of other essential behaviors, such as breeding, communication, and feeding, may also occur.

The risk of exposure and response of whales to small spills occurring in future incremental steps will be similar to descriptions in Sections 6.1.3.9 and 6.1.4.6. This section will focus on expected effects to whales should a large or a VLOS occur.

Depending on the timing, size, and duration of the spill, beluga, fin, and humpback whales could experience contact with fresh oil during feeding events and migration in the action area. If a spill were to occur during the summer on a lease area, beluga whales would be less likely to be exposed due to aggregation at feeding areas in upper Cook Inlet. However, a summer spill would increase the potential for exposure to fin and humpback whales.

Skin and eye contact with oil could cause irritation and various skin disorders. Toxic aromatic hydrocarbon vapors are associated with fresh oil. The rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh oil and disturbance from response related noise and activity could limit the potential exposure of whales to prolonged inhalation of toxic fumes. Exposure of whales to toxic vapors, especially if calves are present, could result in mortality. Cook Inlet beluga whale calves are born from mid-May (Calkins 1983) to October (Tamara McGuire, LGL, pers. Comm, 2017), but calves have not recently been observed in the action area. Humpback whale calves have also been spotted in the action area (Campbell 2014). Calves could be more vulnerable than adults to vapors from a spill, because they take more breaths than do their mothers and spend more time at the surface (BOEM 2015a). Surface feeding whales could ingest surface and near surface oil fractions with their prey, which may also be contaminated with oil components. Incidental ingestion of oil factions that may be incorporated into benthic sediments can also occur during near-bottom feeding. To the extent that ingestion of crude oil affected the weight or condition of the mother, the dependent young could also be affected. Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to accumulate high levels of fat to survive their environment (Geraci and St. Aubin 1990a). Ingestion of oil may result in temporary and permanent damage to whale endocrine function and reproductive system function; and if sufficient amounts of oil are ingested mortality of individuals may also occur (BOEM 2015a).

Cook Inlet beluga whales are most vulnerable to oil spills while feeding during winter and spring in mid and lower Cook Inlet. A winter spill, or if oil persists in ice over winter, could impact beluga whale critical habitat areas. Exposure to aged winter spill oil (which has had a portion or all of the toxic aromatic compounds dissipated into the atmosphere through the dynamic open water and ice activity) presents a much reduced toxic inhalation hazard. It is possible that a winter spill would result in a situation where toxic aromatic hydrocarbons would be trapped in ice for the winter period and released in toxic amounts in the spring. If a VLOS were to occur during a time when many beluga whale calves were present, calves could die and recovery from the loss of a substantial portion of an age class cohort and its contribution to recruitment and species population growth could take decades. As the Cook Inlet beluga whale population is small and resident, any impact from direct or indirect effects from a large oil spill has the potential for population-level impacts (BOEM 2016a).

Injury and mortality to whales are most likely during the initial spill event. Contact through the skin, eyes, or through inhalation and ingestion of fresh oil could result in temporary irritation or long-term endocrine or reproductive impacts, depending on the duration of exposure. We anticipate that if a VLOS were to occur, the magnitude of the resulting impact could be high because a large number of whales could be impacted. The duration of impacts could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g. endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as designated critical habitat, the impacts may be higher magnitude (BOEM 2016a).

Although Cook Inlet beluga whales currently have lower contaminant loads (including PAHs) than other populations of beluga whales (Becker et al. 2000; Wetzel, Pulster, and Reynolds 2010), an increase in PAHs in the Cook Inlet environment from an accidental spill could cause some adverse effects. High levels of PAHs have been offered considered as a factor in illness and mortality among beluga whales in the Saint Lawrence Estuary (Martineau et al., 1994, 2002); however, no definitive causal relationship has been demonstrated (BOEM 2016a). Maternal exposure to crude oil during pregnancy may negatively impact the birth weight of young, and ingestion can decrease nutrient absorption (St. Aubin 1988). Decreased food absorption could be especially important in very young animals, those feeding seasonally, and those needing to develop large amounts of fat for survival (BOEM 2016a).

A large oil spill could displace beluga whales from, or prevent or disrupt access to, affected habitat areas. The loss of nursing/calving habitats by female beluga whales with calves and juveniles could create additional stresses, both physical and psychological, that may reduce the fitness of some individual belugas over time. Some of the effects from displacement might not be easily recovered from, at the very least partially compromising the ability of the stock to recover. A large spill from a production platform or pipeline (5,100 bbl spill from a production platform or a 1,700 bbl from a pipeline) would have limited potential to affect Cook Inlet belugas due to the size of the spill, existing spill response plans, the unlikelihood of spills co-occurring in space and time with the seasonal occurrence of beluga in the action area, and the dispersion/weathering of the spill over hours or possibly days as the spill is released (BOEM 2016a).

Humpback whales are at highest risk from impacts to oil spills during the summer and fall in their feeding areas around Kodiak Island corresponding to Environmental Resource Areas (ERAs) 76-79 (adjacent to Kodiak Island), areas that are deemed Biologically Important Areas (BIAs) for humpback and fin whale feeding (Ferguson et al. 2015b). The highest densities of humpback whales in this BIA occur from July through September (Witteveen et al. 2007, 2011). Fin whale densities peak slightly earlier in the summer from June through August, although they have been observed year-round in the action area (BOEM 2016a). An additional ERA for humpback whales occurs just north of the feeding BIA, on the southern extent of the Kenai Peninsula, another area of high use by humpback whales in the summer (BOEM 2016a). Because of their distribution, the primary potential adverse effect on humpback whales would be from a large spill that contacted waters adjacent to Kodiak Island, including Shelikof Strait, especially during the summer for both humpback and fin whales and into the fall for humpback whales when densities are highest in this area (BOEM 2016a).

Upon contacting spilled oil, humpback and fin whales may experience inhalation, ingestion, and skin and conjunctive tissue irritation similar to other whales. Because they also are mysticetes, humpback and fin whales may experience baleen fouling as well (BOEM 2016a).

Several investigators have observed various cetaceans in spilled oil, including humpback whales, fin whales, gray whales, dolphins, and pilot whales. Typically, the whales did not avoid slicks but swam through them, apparently showing no reaction to the oil. During the spill of Bunker C and No. 2 fuel oil from the M/V *Regal Sword*, Geraci and St. Aubin (1990) saw humpback and fin whales, and a whale tentatively identified as a right whale, surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts.

Von Ziegesar et al. (1994) found no indication of a change in abundance, calving rates, seasonal residency time of mother-calf pairs, or mortality in humpback whales as a result of the Exxon Valdez Oil Spill, although they did see temporary displacement from some areas of Prince William Sound.

A large or very large oil spill could result in some individual humpback or fin whales coming into contact with oil (potentially resulting in inhalation of hydrocarbon vapors, baleen fouling, and ingestion of contaminated prey). Temporary and/or permanent injury and non-lethal effects could occur, but mortality is not likely. Temporary displacement from feeding and resting areas could also occur. Fin and humpback whale prey (schooling forage fish and zooplankton) could be reduced or contaminated, leading to modified distribution of these whales (BOEM 2015a, 2016a). Duesterloh, Short, and Barron (2002) concluded that phototoxic effects on copepods could cause ecosystem disruptions that have not been accounted for in traditional oil spill damage assessments. As such, the greatest impact of an oil spill on humpback whales could occur indirectly (BOEM 2016a).

A large spill, depending on the timing and location relative to the distribution and aggregations of zooplankton, could reduce feeding opportunities for humpback and fin whales during the year of the spill. The significance of the loss of that opportunity to whales' health depends on major feeding opportunities humpback and fin whales may find later in the year to meet annual energy demands. Given that the OSRA model estimates that a large spill could contact the waters around Kodiak Island and the Shelikof Strait, a biologically important feeding area for humpback and fin whales, potential adverse impacts to their prey health and availability could occur (BOEM 2016a). In addition, Mizroch et al. (2009) concluded fin whales are probably present in waters of Shelikof Strait, off the Kodiak Archipelago, and other northerly areas in winter because of the prey presence and distribution in those areas. This suggests that a spill at any time of year may overlap with fin whales. Fate, recovery, and availability of zooplankton and fish populations to whales in similar quantities and locations as pre-spill conditions in LS 244 and the OSRA study area in subsequent years would depend on a variety of factors.

Beluga, fin, and humpback whales are thought to be vulnerable to incremental long-term accumulation of pollutants given their extreme longevity. With increasing development within their range and long-distance transport of other pollutants, individual whales may experience multiple large and small polluting events as well as chronic pollution exposure within their lifetime (BOEM 2016a).

Although unlikely, BOEM estimates that a well control incident of a single well could result in the release of 8 million cubic feet (MMcf) of natural gas in one day during the development, production, or decommissioning phase due to development plan activities. Most gas escaping and contacting water would dissipate quickly, likely resulting in no large-scale effects on marine mammals, although some marine mammals in the immediate vicinity of a large natural gas release could be exposed to toxins and die before the gas could volatize. A gas release is expected to have negligible to minor effects on marine mammals (BOEM 2016a).

The disappearances (and probable deaths) of killer whales and the deaths of large numbers of gray whales coincided with the Exxon Valdez Oil Spill and with observations of members of both species in oil (Matkin et al. 2008). It is anticipated that if other odontocetes (e.g., Cook Inlet beluga) or baleen whales (e.g,. humpback or fin whales) were exposed to a large spill, mortalities may also occur depending on the time of year, location of spill, and extent of the VLOS. Cook Inlet beluga whales may be severely impacted at the individual and population level by a VLOS event (BOEM 2016a). The Cook Inlet Beluga Recovery Plan indicated that a spill in a more centrally located area of Cook Inlet beluga habitat will increase the exposure of the animals and increase the severity of the impact, to the point recovery of the population could be delayed (NMFS 2016d).

A low probability, high impact circumstance where large numbers of whales experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality that exceeds the stock’s potential biological removal (PBR), causing negative population-level impacts. However, due to the low likelihood of multiple large oil spills, and even lower predicted likelihood of a VLOS, the risk of exposure of a significant number of whales (relative to the size of the population) to such discharges of oil is low. In addition, past exposures to Exxon Valdez VLOS provided no indication of a change in abundance, calving rates, seasonal residency time of mother-calf pairs, or mortality in humpback whales.

6.2.6.2 Effects to Pinnipeds (Western DPS Steller Sea Lions)

In the event of an oil spill, western DPS Steller sea lions could be adversely affected to varying degrees depending on habitat use, densities, season, and various spill characteristics. The risk of exposure and response of Steller sea lions to small spills occurring in future incremental steps will be similar to descriptions in Section 6.1.3.9 and 6.1.4.6. This section will focus on expected effects to Steller sea lions should a large or a VLOS occur.

Steller sea lions occur year round in the action area. Based on BOEM's OSRA model, all of the ERAs with a percent chance of contact occur within designated critical habitat (see Section 4.3.6.8 and Appendix A, Table A.1-9, in BOEM 2016a for additional information).

Sea lions contacted by oil could absorb hydrocarbons internally through inhalation, contact and absorption through the skin, or ingestion directly or indirectly by consuming contaminated prey (Engelhardt 1987). Effects to pinnipeds from exposure to oil can include mortality, brain and liver lesions, skin irritation and conjunctivitis, increased PAH concentrations in blubber, increased petroleum related aromatic compounds in bile, and abnormal behavior such as lethargy, disorientation, and unusual tameness (Calkins et al. 1994a, Loughlin et al. 1996, BOEM 2016a).

Floating sea ice reduces wave action and surface exchange thus delaying the weathering and dispersion of oil and increasing the level and duration of exposure to sea lions. Low temperatures make oil more viscous and thus increase the hazards associated with fouling of animals. It also reduces evaporation of volatile hydrocarbons, lessening the acute levels of toxins in the air but lengthening the period of exposure (Engelhardt 1987).

Surface contact with petroleum hydrocarbons, particularly the low-molecular-weight fractions, to pinnipeds can cause temporary damage of the mucous membranes and eyes (Davis et al. 1960) or epidermis (Walsh et al. 1974, Hansbrough et al. 1985, St. Aubin 1988). Contact with crude oil can damage eyes (Davis et al. 1960), resulting in corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes (Geraci and Smith 1976a, b). Crude oil immersion studies resulted in 100% mortality in captive ringed seals (Geraci and Smith 1976a). Unlike the animals in the immersion study, pinnpeds in the wild would have haulouts as a resting/escape platform or, water depth and distance for escape routes from an oil spill, which some individuals might detect and avoid (Geraci and St. Aubin 1990b). Inhalation of highly concentrated petroleum vapors can cause inflammation and damage to the mucous membranes of airways, lung congestion, hemorrhagic bronchopneumonia, and pulmonary edema in severe cases (Zieserl 1979). After extreme exposure, asphyxiation may occur (Geraci and St. Aubin 1982).

As mentioned in Section 6.1.4.5, much of what is known about impacts of crude oil spills on Steller sea lions was learned from the Exxon Valdez Oil Spill. Sea lions did not seem to avoid the oil, and were sighted swimming in or near slicks (Calkins et al. 1994b). After the Exxon Valdez Oil Spill, Calkins et al. (1994) recovered 12 Steller sea lion carcasses from the beaches of Prince William Sound and collected 16 additional Steller sea lions from haul-out sites in the vicinity of Prince William Sound, the Kenai coast, and the Barren Islands. The highest levels of PAHs were in animals found dead following the oil spill in Prince William Sound. Furthermore, sea lion bile samples collected 7 months after the spill had levels of PAH metabolites consistent with exposure to PAHs (Calkins et al., 1994).

The decline in Steller sea lions has been linked to reductions in prey biomass and quality, resulting in nutritional stress that subsequently decreased vital rates (Kucey and Trites, 2006). Depending on the extent of the reduction in quantity and quality of prey species for an oil spill, the consequences of such a loss in the prey base could include: decreased rates of reproduction or survivorship by reducing individual condition or fitness, or displacement from their habitat due to loss of prey availability (BOEM 2016a).

Reduction or contamination of food sources would be localized relative to the area of the spill. Exposure to contaminated prey multiple times over the long lifetime of these sea lions could increase contamination of tissues through accumulation. A VLOS could affect large numbers of sea lions, because they would be exposed to contaminated prey in a large area for a sustained amount of time. Because the statistical probability of large and especially very large oil spills occurring is very small, any consumption of contaminated prey is unlikely to accumulate to levels that would harm individual sea lions.

Although unlikely, BOEM estimates that a well control incident of a single well could result in the release of 8 MMcf of natural gas in one day during the development, production, or decommissioning phase due to development plan activities. Most gas escaping and contacting water would dissipate quickly, likely resulting in no large-scale effects on marine mammals, although some marine mammals in the immediate vicinity of a large natural gas release could be exposed to toxins and die before the gas could volatize. A gas release is expected to have negligible to minor effects on marine mammals (BOEM 2016a).

A low probability, high impact circumstance where large numbers of Steller sea lions experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality of a substantial number of sea lions. However, due to the low likelihood of multiple large oil spills, and even lower predicted likelihood of a VLOS, the risk of exposures of sea lions to such discharges of oil is low.

6.2.6.3 Effects to Designated Critical Habitat (Cook Inlet Beluga and Steller Sea Lion)

In the event of an oil spill, Cook Inlet beluga and Steller Sea lion critical habitats could be adversely affected to varying degrees depending on habitat use, season, and various spill characteristics. The potential effects to designated critical from small spills was analyzed under the first incremental step and effects from small spills in future incremental steps is anticipated to be similar to what is described in Sections 6.1.3.9 and 6.1.4.6. This section will focus on expected effects to Cook Inlet beluga and Steller sea lion designated critical habitats should a large or a VLOS occur.

Cook Inlet Beluga Critical Habitat

This section discusses the chance that a large oil spill, assuming one occurs, could contact beluga whale critical habitat (summarized in BOEM 2016a, Table 4.3.6-8) and is analyzed in terms of the habitat associated with certain ERAs (defined in BOEM 2016a, Appendix A, Table A.1-8). The potential effects of a large oil spill considers the highest chance of contact within 3 or 30 days, summer or winter, from any launch area or pipeline (BOEM 2017b).

Four environmental resource areas in the action area are relevant to Cook Inlet belugas. These include ERA 16, 70, 71, and 72. Cook Inlet beluga whale critical habitat is vulnerable in these ERAs year-round as are the species within critical habitat (Hobbs et al. 2005) (BOEM 2016a Appendix A, Table A.1-8). The highest chance of contact is divided into four quantile ranges as follows (with references to relevant maps in the EIS (BOEM 2016a, see Appendix A)):

- ≥50% – ERA 72, West Cook Inlet Beluga Critical Habitat (Map A-2b)
- ≥25% to <50% – ERA 71, Middle Cook Inlet Beluga Critical Habitat (Map A-2b)
- ≥6% to <25% – ERA 16, Inner Kachemak Bay (Map A-2b)
- ≥0.5% to <6% – ERA 70, Forelands Beluga Critical Habitat (Map A-2a)
- <0.5% - ERA 69, Upper Cook Inlet Beluga Critical Habitat (Map A-2a)

ERAs 70 to 72 occur in Cook Inlet beluga whale Critical Habitat Area 2, an area designated as important for fall and winter feeding and transit. ERA 72 is in the far southern extent of the Cook Inlet beluga whale range and has the highest probability of oil spill trajectories contacting. Beluga whales would be unlikely to occur in ERA 72 in the summer months in any great number. ERA 71 and 70 both occur in the mid inlet, where beluga whales are known to occur year round, although they generally concentrate in the upper inlet during the summer. These ERAs occur in areas considered to be year-round Small and Resident Population BIAs for beluga whales (Ferguson et al. 2015b). As the Cook Inlet beluga whale population is small and resident to Cook Inlet, any impact from direct or indirect effects from a VLOS could have severe population-level impacts. ERA 69 (Upper Cook Inlet; Appendix A, Map A-2a) is also important habitat for beluga whales, but that area has <0.5% trajectories contacting land. (BOEM 2016a).

A large oil spill could disrupt access to affected beluga whale critical habitat areas. A large spill (5,100 bbl from a production platform, or a 1,700 bbl from a pipeline), would have limited potential to affect beluga critical habitat due to existing spill response plans, the dispersion/weathering of the spill over hours or days, and the large spatial extent of critical habitat (BOEM 2017b).

The VLOS scenario assumes a hypothetical spill of 120,000 bbl of oil and assumes an average release rate of 1,500 bbl per day for 80 days (BOEM 2016a). Much of what is known about the effects of a VLOS on marine mammals stems from studies associated with the Exxon Valdez Oil Spill in Prince William Sound, the Selendang Ayu Oil Spill in the Aleutian Islands, and the Deepwater Horizon Oil Spill in the Gulf of Mexico. Impacts to marine mammals from a hypothetical VLOS may include mortality, long-term sub-lethal impacts (e.g., decreased reproduction and survival rates over time), and impacts to healthy prey availability.

A large spill could affect fish within the Cook Inlet beluga critical habitat that serve as prey items for belugas. Fish species from these resource areas potentially affected by a large oil spill include adult anadromous fishes and eulachon transiting lower Cook Inlet; out-migrating juvenile salmon entering western Cook Inlet from natal rivers and streams; herring, Pacific cod, and halibut; and walleye pollock in offshore waters in western and southern Cook Inlet. Additionally, fish and shellfish pelagic eggs and juvenile stages inhabiting near-surface waters may experience lethal and sub-lethal effects from a large spill (BOEM 2017b).

Steller Sea Lion Critical Habitat

Twenty one Steller sea lion ERAs (23 to 44) are relevant to Cook Inlet and the surrounding region. The highest chance of contact is divided into four quantile ranges as follows (with references to relevant maps in the EIS (BOEM 2016b, Appendix A)):

- ≥6% to <25% – ERA 23, Barren Islands Pinnipeds (Map A-2b); ERAs 24 and 25, Shelikof MM2 and 3 (Map A-2d); ERA 26, Shelikof MM4 (in summer only) (Map A-2d)

- ≥0.5% to <6% – ERAs 23, 24, 27-32, 37, 38, and (Table 4.3.2-16)
- All other Steller sea lion ERAs have a <0.5% chance of contact within 3 or 30 days during summer or winter

Steller sea lions are listed as vulnerable in these ERAs year round. These ERAs were designated because they contain important habitat features such as rookeries (e.g., ERAs 31 and 23), major haulouts (and their surrounding aquatic zones), and aquatic foraging areas (e.g., ERAs 24 to 26). The OSRA model estimates that a large spill could contact the waters around Kodiak Island and the Shelikof Strait special aquatic foraging area.

For both Cook Inlet beluga whale and Steller sea lion critical habitats, research on effects of oil spills have stated that the likely effects of a large or VLOS oil spill would include the mortality of adult forage fishes as well as lethal and sub-lethal effects to millions of eggs and the juvenile stages of finfishes and shellfishes. A large spill could measurably depress and affect local populations of nearshore fish and shellfish for about a year, and small amounts of oil could persist in shoreline sediments for a decade or more, possibly affecting beluga whales and Steller sea lions in the area for multiple generations. For this level of impact to occur, however, all of the following would have to occur: (1) one large oil spill occurs (the estimated likelihood of one or more large spills occurring is 22% and the chance of no spills occurring is 78% over the life of the proposed action); (2) the spill would occur during the summer or fall seasons, when many pelagic migratory finfish are most abundant and have eggs and juvenile stages in the central Gulf of Alaska; (3) the oil would contact and compromise a large portion of the ERA and associated prey species, and (4) no clean-up efforts would occur (the OSRA trajectory model is based on the movement of unweathered oil with no mitigation from oil spill response activities). While *any* of these events is possible, BOEM concludes that it is not reasonably likely/reasonably expected that *all* of these events would occur simultaneously, based on the best information currently available. Consequently, while a large spill could have effects on whales and Steller sea lions through long-lasting adverse impacts to prey species, such effects are not likely to occur (BOEM 2017b).

6.2.7 Anticipated Effects from Decommissioning Operations

Decommissioning would commence after both oil and gas resources are depleted, and income from production no longer pays operating expenses. BOEM and BSEE estimate that decommissioning activities would begin in the 35th year. Vessels would be used to plug wells with cement permanently. Wellhead equipment would be removed and processing modules would be moved off the platforms. Subsea pipelines and flowlines would be decommissioned by cleaning the line, plugging both ends, and leaving it in place buried in the seabed. Lastly, the platform would be disassembled and removed from the area and the seafloor site would be cleared of all obstructions. Cutters are typically used to remove platform legs. Explosive use for platform removal is rare in the marine environment; it is considered highly improbable, and for the purposes of this opinion is considered not reasonably foreseeable. Post-decommissioning surveys would be required to confirm that no debris remains following decommissioning and that pipelines were abandoned properly (BOEM 2017b). Such surveys, including dragging the bottom in the vicinity of the platform location with a trawl, could cause disturbance to a small area of substrate. In Cook Inlet, effects of this disturbance would likely be temporary.

Discharges from decommissioning activities would be regulated under NPDES permits. Discharges authorized under the General Permit include sanitary waste, domestic waste, deck drainage, desalination unit waste, cooling water, ballast and bilge water, and other miscellaneous effluents (BOEM 2017b).

During decommissioning there would be a surge of heavy equipment and vessel activity engaged in disassembling platforms and transporting them from the area, and performing any reclamation activities deemed necessary. There would also be a corresponding increase in the number of aircraft flying personnel and supplies to camps engaged in decommissioning. These activities are a potential source of noise, disturbance, or injury.

6.2.7.1 Effects to Listed Species

The effects associated with decommissioning activities are anticipated to be similar to those described under construction activities (see Section 6.2.2). Mitigation measures would reduce impacts to listed species and critical habitat.

Production equipment would be partly disassembled and moved off the platform during the summer open-water season. This could affect listed species, but the effects are anticipated to be similar to construction activities and are anticipated to cause only temporary avoidance.

After decommissioning, the area would be re-colonized by benthic invertebrates and fishes. The period of time it would take for re-colonization to occur would depend upon the size of the disturbed area and other factors (BOEM 2017b).

6.2.8 Anticipated Effects from Oil Spill Drill Activities

Oil spill response activities are anticipated to occur throughout future incremental steps (years 7-39). One exercise per operator is required every 1-3 years with each exercise lasting no more than one day. Exercises may involve offshore and shoreline-based equipment deployment. Equipment may include containment boom and temporary storage devices (bladders towed in water or placed on the beach and fast tanks placed on the beach). A likely scenario may include up to 30 vessels (e.g., OSRVs, M/V, Class 2,3,5,6, and 8 vessels, containment barges, and skiffs). Helicopters and fixed winged aircraft may be used for personnel transport and area overflights (BOEM 2017b).

While the range of effects to whales, pinnipeds, and designated critical habitats associated with oil spill drill activities are anticipated to be similar to those described during the first incremental step (see Sections 6.1.4.6), the frequency of those activities is anticipated to increase during the development and production phases. In addition, the time over which spill drills associated with production and development occurs will be far greater than that for exploration-associated spill drills, and they may occur at any time of year (BOEM 2017b).

During spill drills, whales and pinnipeds could be exposed to harassment levels of noise from vessels and increased risk of ship strike. Whales and pinnipeds are vulnerable to entanglement with underwater lines and could be injured or killed if they become badly entangled in underwater response equipment (e.g., boom lines or anchoring systems), particularly if the equipment is left unattended. However, exposures would be reduced by implementing mitigation measures identified in the OSRPs and through consultation with NMFS (e.g., having observers on vessels, minimizing boom installation, and minimizing in water time).

Oil spill response activities are not a component of the proposed action and have been previously consulted on by NMFS as part of the *Alaska Federal/State Preparedness Plan for Response to Oil & Hazardous Substance Discharges/Releases (Unified Plan)* consultation (AKR 2014-9361).

7 CUMULATIVE EFFECTS

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate change within the action area. However, it is difficult to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline and cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 5.0).

7.1 Fisheries

Fishing, a major industry in Alaska, is expected to continue in Cook Inlet. As a result, there will be continued risk of prey competition, ship strikes, harassment, entanglement in fishing gear, and, perhaps most notably, displacement from former summer foraging habitat for the Cook Inlet beluga whales (e.g., waters within and near the outlets of the Kenai and Kasilof Rivers during salmon season) (Figure 25) (Castellote et al. 2016). NMFS and the ADF&G will continue to manage fish stocks and monitor and regulate fishing in Cook Inlet to maintain sustainable stocks. It remains unknown whether and to what extent Cook Inlet beluga whale prey may be less available due to commercial, subsistence, personal use, and sport fishing, especially near the mouths of streams up which salmon and eulachon migrate to spawning areas. The Cook Inlet Beluga Whale Recovery Team considered reduction in availability of prey due to activities such as fishing to be a moderate threat to the population.

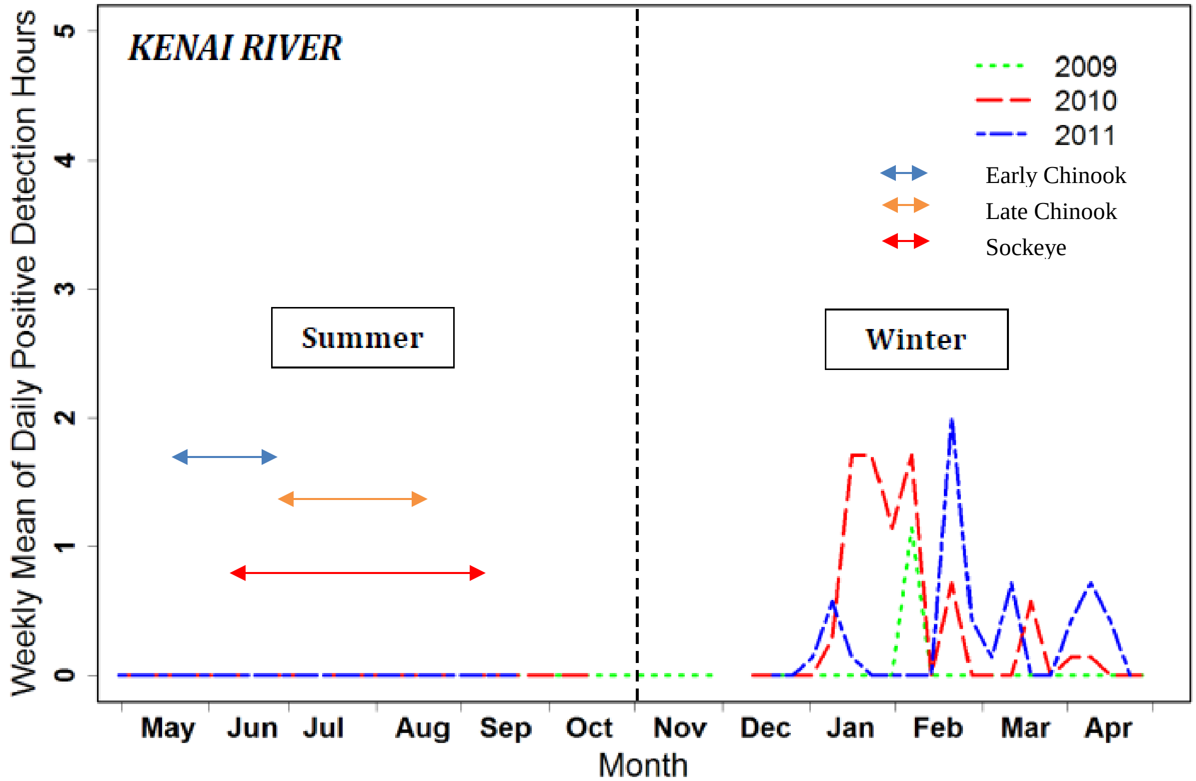


Figure 25. **Acoustic detections of Cook Inlet beluga whales in the Kenai River from 2009 through 2011 compared to Chinook and Sockeye run timing. From Castellote et al. (2016) and fish run timing data at http://www.adfg.alaska.gov/sf/FishCounts/index.cfm?adfg=main.home (accessed August 3, 2017).**

7.2 Oil and Gas Development

It is likely that oil and gas development will continue in Cook Inlet with associated risks to marine mammals from seismic activity, vessel and air traffic, well drilling operations, wastewater discharge; habitat loss, and potential for oil spills and natural gas well blowouts. Any such proposed development would undergo ESA section 7 consultation and therefore the associated effects are not cumulative effects pursuant to the ESA.

7.3 Coastal Development

Coastal development may result in the loss of habitat, increased vessel traffic, increased pollutants, and increased noise associated both with construction and with the activities associated with the projects after construction. Any projects with a Federal nexus (e.g. Chuitna Coal Mine, ORPC Tidal Energy Projects, Port of Anchorage expansions) will require ESA section 7 consultation. However, as the human population in the area increases, coastal development with unspecified impacts to Cook Inlet could increase, and vessel traffic in the area could increase.

7.4 Pollution

As the population in urban areas around Cook Inlet continues to grow, an increase in pollutants entering Cook Inlet is likely to occur. Hazardous materials may be released into Cook Inlet from vessels, aircraft, and municipal runoff. Oil spills could occur from vessels traveling within the action area. In addition, oil spilled from outside the action area could migrate into the action area. There are many nonpoint sources of pollution within the action area; such pollution is not federally-regulated. Pollutants can pass from streets, construction and industrial areas, and airports into Cook Inlet and beluga whale habitat. However, the EPA and the ADEC will continue to regulate the amount of pollutants that enter Cook Inlet from point and nonpoint sources through NPDES/APDES permits. As a result, permittees will be required to renew their permits, verify they meet permit standards, and potentially upgrade facilities. However, pollutants of emerging concern such as flame retardants and estrogen mimics are unregulated and are not monitored. NMFS plans to investigate the occurrence of such contaminants in municipal outfalls around Cook Inlet in the near future.

7.5 Tourism

There currently are no commercial whale-watching companies in upper Cook Inlet. The popularity of whale watching and the close proximity of beluga whales to Anchorage make it possible that such operations may exist in the future. However, it is unlikely this industry will reach the levels of intensity seen elsewhere because of upper Cook Inlet's climate and navigation hazards (e.g., shallow waters, extreme tides, high turbidity, and swift currents). We are aware, however, that some aircraft have circled around groups of Cook Inlet beluga whales, disrupting their breathing patterns and possibly their feeding activities. NMFS has undertaken outreach efforts to educate local pilots of the potential consequences of such actions, providing guidelines and encouraging pilots to "stay high and fly by".

Poorly-managed vessel-based whale watching in upper Cook Inlet may cause additional stress to the beluga whale population through increased noise and intrusion into beluga whale habitat not ordinarily accessed by boats. However, within the action area, such effects are unlikely to occur due to the low density of beluga whales and the low likelihood that vessel operators would be able to target them in a commercially viable way. Humpback whales are sufficiently numerous and easy to find within the action area such that whale watching may affect the behavior of some whales in lower Cook Inlet, primarily in the vicinity of Homer. Fin whales, being less common and arguably less charismatic than either humpback or beluga whales, are not likely to be a target for whale watching operations, but they would likely stop to observe those that they may encounter.

Avoidance reactions have often been observed in beluga whales when approached by watercraft, particularly small, fast-moving craft that are able to maneuver quickly and unpredictably; larger vessels that do not alter course or speed often cause little to no reaction among whales in Cook Inlet (NMFS 2008a). The small size and low profile of beluga whales, and the poor visibility within the Cook Inlet waters, may increase the temptation for whale watchers and other small watercraft operators to approach the beluga whales more closely than the 100-m minimum approach distance recommended by NMFS marine mammal viewing guidance (https://alaskafisheries.noaa.gov/pr/mm-viewing-guide).

Watercraft have been observed to harass belugas in the Twentymile River during April. It is likely that such harassment also occurs during late summer coho salmon runs in the same area. NMFS is cooperating with partners to assess the degree to which such boating activities may be a cause for concern due to the associated reduced access to concentrations of prey.

Watercraft regularly approach western DPS Steller sea lion non-major haulouts (haulouts that were not used in determining the extent of critical habitat) near Homer, but data are not available indicating whether such marine mammal viewing adversely affects the animals.

7.6 Subsistence Hunting

Alaska Natives are not currently authorized to hunt Cook Inlet beluga whales, fin whales, or humpback whales, but they can hunt harbor seals, sea lions, and other marine mammals (that are not large cetaceans) in Cook Inlet for subsistence purposes. Harbor seal hunts are typically boat-based hunts that could temporarily increase noise in the environment and increase the potential for accidental small vessel strikes of Cook Inlet beluga whales and other marine mammals. Any future hunts of Cook Inlet beluga whales and large cetaceans will require a Federal authorization and are not considered under the ESA definition of cumulative impacts. Harvest of western DPS Steller sea lions occurs under co-management agreements with NMFS, and occurs at or well below sustainable levels of harvest.

8 INTEGRATION AND SYNTHESIS

The Integration and Synthesis section is the final step of NMFS's assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) result in appreciable reductions in the likelihood of the survival or recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) result in the adverse modification or destruction of critical habitat as measured through potential alterations or reductions in the value of designated critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species (Section 4).

As we discussed in the *Approach to the Assessment* section of this opinion, we begin our risk analyses by asking whether the probable physical, physiological, behavioral, or social responses of endangered or threatened species are likely to reduce the fitness of endangered or threatened individuals or the growth, annual survival, or reproductive success, or lifetime reproductive success of those individuals.

In addition to considering the effects of stressors associated with the activities proposed in the first incremental step, we analyzed the effects of the future incremental steps, including exploration, development, production, and decommissioning activities on LS 244, to determine if there is reasonable likelihood that the entire proposed action could violate section 7(a)(2) of the ESA (50 CFR §402.14(k)). However, considerable uncertainty remains concerning future activities. If project-specific effects on the listed species or designated critical habitat will occur in a manner or to an extent not considered in this opinion, reinitiation of this consultation would be required. Consultation also will be required for all activities related to LS244 that may affect listed species. In addition, activities that are expected to result in take of marine mammals under the Marine Mammal Protection Act will require the issuance (by NMFS) of an Incidental Harassment Authorization or Letter of Authorization. If the expected take includes listed marine mammal species, then a formal consultation on the issuance of those authorizations is required.

8.1 Cetacean Risk Analysis

Based on the results of the *Exposure Analysis* for the first incremental step, we expect Cook Inlet beluga whales, fin whales, and Western North Pacific DPS and Mexico DPS humpback whales may be adversely affected by exposure to seismic exploration noise, drilling noise, pile driving noise, anchor handling, use of dynamic positioning or thrusters, and tug transport of drill rigs. Exposure to vessel noise (excluding tugs and drill ships), aircraft noise, noise from non-seismic geohazard surveys, seafloor disturbance, and small oil spills may occur, but the expected effects are considered minimal and would not likely result in take. We expect take will result from vessel noise associated with tug movement of jack-up rigs and with use of drill ships. As discussed below, exposure to vessel strike is extremely unlikely to occur and therefore the expected effects are considered improbable. We have records of only one humpback having been struck in the action area, and perhaps one fin whale having been struck (one vessel showed up at the Port of Anchorage with a dead fin whale on its bow, but the location of the strike was unknown, and the majority of that vessel's transit was outside of the action area). Exposure to certain non-biodegradable marine debris, especially to closed loops such as packing straps, remains an unquantifiable threat, especially to smaller cetaceans such as beluga whales. Finally, large and very large oil spills are considered low probability, high-impact events.

Our consideration of probable exposures and responses of listed whales to oil and gas exploration activities associated with the first incremental step of LS 244 is designed to help us assess whether those activities are likely to increase the extinction risks or jeopardize the continued existence of listed whales.

The effects to Cook Inlet beluga, fin, and Mexico DPS and Western North Pacific DPS humpback whales associated with geohazard, geotechnical, pile driving, aircraft traffic, drilling operations, and small oil spills during future incremental steps (development, production, and decommissioning) are anticipated to be similar those effects described for whales during the first incremental step, but with increased sound exposures and risk of spill due to increased vessel and aircraft traffic, installation of production platforms and pipelines, and drilling operations. Mitigation measures required for pile driving, pipeline and platform installation, and drilling would reduce the impacts to listed whales (BOEM 2017b). In addition, the risk associated with large oil spills is anticipated to increase during future incremental steps. BOEM estimates that during future incremental steps, there is a 78 percent probability of no large spill occurring, and a 22 percent probability of one or more large spills occurring (1,700 – 5,100 bbl), over the life of the project, with a far smaller chance that this spill will occur during the first incremental step, prior to the establishment of production wells. No VLOS is expected (>10^{-4} to <10^{-5} per well frequency of occurrence). The effects of a large oil spill would be significantly greater than small spills. A low probability, high impact circumstance where large numbers of whales experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality that exceeds PBR. However, due to the low likelihood of multiple large oil spills, and even lower predicted likelihood of a VLOS, the risk of significant long term exposures of whales to accidental discharges of oil is extremely low. In addition, a number of regulatory changes have been put in place since Deepwater Horizon in an effort to reduce the risk of spills associated with oil and gas exploration and development activities.

The primary mechanism by which the behavioral changes we have discussed affect the fitness of individual animals is through the animal’s energy budget, time budget, or both (the two are related because foraging requires time). Large whales such as fin and humpbacks have an ability to store substantial amounts of energy, which allows them to survive for months on stored energy during migration and while in their wintering areas, and their feeding patterns allow them to acquire energy at high rates. For smaller cetaceans, like Cook Inlet beluga whales, foraging is anticipated to occur year-round on seasonally available prey. During spring and summer beluga whales congregate in upper Cook Inlet feeding mainly on anadromous fish, including eulachon and Pacific salmon near river mouths outside the action area. The individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of these whales (i.e., reduce the amount of time they spend at the ocean’s surface, increase their swimming speed, change their swimming direction to avoid tug operations, change their respiration rates, increase dive times, reduce feeding behavior, or alter vocalizations and social interactions) and their probable exposure to noise sources are not likely to reduce their fitness or current or expected future reproductive success or reduce the rates at which they grow, mature, or become reproductively active. Therefore these exposures are not likely to reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent.

Based on the exploration scenarios provided by BOEM/BSEE for the first incremental step (BOEM 2017b) (Table 1), NMFS estimated take when drill rigs are used (Table 18) of about 160 Cook Inlet beluga whales, 51 fin whales, 2 Western North Pacific DPS Humpback whales, and 40 Mexico DPS humpback whales. If drillships are used, we estimate take (Table 19) of about 305 Cook Inlet beluga whales, 99 fin whales, 4 Western North Pacific DPS Humpback whales, and 76 Mexico DPS humpback whales at received levels ≥120 dB re 1 μPa rms for continuous noise sources and ≥160 dB e 1 μPa rms for impulsive noise that might result in behavioral harassment (see Section 6.1.4, *Response Analysis*). No whales are anticipated to be exposed to sound levels that could result in TTS or PTS.

These estimates represent the total number of takes that could potentially occur, over five years, but not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of the proposed action (here, the first incremental step, years 1-5). These take estimates are likely to be overestimates because the estimates assume a uniform distribution of animals in the action area, do not account for avoidance or mitigation measures, and assume all activities associated with the first incremental step are implemented (see Tables 17-19).

Exposure to vessel noise from transit, aircraft noise, noise from non-seismic geohazard surveys, seafloor disturbance (including geotechnical surveys), and small oil spill discharge may occur as part of the proposed action, but the effects are considered undetectable and would not rise to the level of take. The occurrence of vessel strikes are considered unlikely due to the implementation of mitigation measures. We have records of only one humpback having been struck in the action area, and perhaps one fin whale having been struck (one vessel showed up at the Port of Anchorage with a dead fin whale on its bow, but the location of the strike was unknown, and the majority of that vessel’s transit was outside of the action area). Exposure to harmful marine debris is unlikely, but exposure to non-biodegradable loops (such as uncut packing straps) remain an unquantifiable threat. Large and very large oil spills are considered low probability, high impact events during the first incremental step (years 1-5) (see Sections 6.1.3.2 through 6.1.3.7).

Based on the localized nature of small oil spills, the relatively rapid weathering expected for <1,000 bbl of oil, the small number of refueling activities in the proposed action, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of a BOEM/BSEE authorized activity within the first incremental step causing a small oil spill and exposing beluga, fin, Mexico DPS humpback, or Western North Pacific DPS humpback whales on LS 244 in Cook Inlet is sufficiently small as to be considered improbable. If exposure were to occur, due to the ephemeral nature of small, refined oil spills, NMFS does not expect detectable responses from whales, and we would consider the effects of a spill (of the size considered by BOEM in their spill analysis) during the first incremental step of the proposed action to be minor.

For jack-up rig drilling operations, PSOs are not required for monitoring. Estimated take for drilling from jack-up rigs is low, and mitigation is impractical: the drilling unit does not have the ability to power- or shut-down if marine mammals enter the associated 120 dB disturbance zone.

Considering that drilling will be a continuous source of underwater noise, we expect that most marine mammals would not enter into an area where they would suffer from acoustic harassment unless they were compelled to do so (such as to take advantage of prey aggregations). We expect most marine mammals will deflect around the ensonified area.

Although the oil and gas exploration activities are likely to cause some individual whales to experience changes in their behavioral states that might have adverse consequences (Frid and Dill. 2002), these responses are not likely to alter the physiology, behavioral ecology, and social dynamics of individual whales in ways or to a degree that would reduce their fitness because it is anticipated that the whales will continue to actively forage in waters around the seismic operations or will seek alternative foraging areas, including the biologically important feeding areas around Kodiak Island.

As we discussed in the *Approach to the Assessment* section of this opinion, an action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of such populations). For the same reasons, an action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise; in this case, the Cook Inlet beluga, fin, Mexico DPS humpback, or Western North Pacific DPS humpback whale. As a result, the exploration activities BOEM and BSEE plan to authorize during the first incremental step on LS 244 in Cook Inlet for the first five years are not likely to appreciably reduce the Cook Inlet beluga, fin, Mexico DPS humpback, or Western North Pacific DPS humpback whales' likelihood of surviving or recovering in the wild.

The strongest evidence supporting the conclusion that exploration activities will likely have minimal impact on fin and humpback whale populations is the estimated growth rate of these populations in the sub-Arctic and North Pacific. Zerbini et al.(2006) estimated the rate of increase for fin whales in coastal waters south of the Alaska Peninsula to be around 4.8 percent (95 percent CI: 4.1-5.4 percent) for the period 1987-2003. The maximum net productivity rate for the Northeast Pacific fin whale stock is estimated to be 4 percent (Muto et al. 2017b). While there is no accurate estimate of the maximum productivity rate for Western North Pacific DPS or Central North Pacific stocks of humpback whales, it is assumed to be 7 percent (Wade and Angliss 1997, Muto et al. 2017b). Despite exposure to oil and gas exploration activities in Cook Inlet since the early1960s, a small number of humpback and fin whale entanglements in fishing gear, and unauthorized subsistence take of small numbers of humpback whales in Alaska, this increase in the number of listed whales suggests that the stress regime these whales are exposed to in the action area has not prevented humpback and fin whales from increasing their numbers and expanding their range and frequency of occurrence in the action area.

NMFS estimated the Cook Inlet beluga population to be about 328 animals as of 2016, with a 10-year (2004-2014) declining trend of 0.5 percent per year (Shelden et al. 2017). The 2-6 percent per year recovery that we expected following the discontinuation of subsistence harvest has not occurred. Summer range has contracted steadily since the late 1970s (Figure 7). Whereas Cook Inlet beluga whales formerly made more extensive summer use of the waters off of the Kenai and Kasilof Rivers, they now make little to no use of this salmon-rich habitat during summer salmon runs (Figure 25). This represents a substantial reduction in availability of summer prey.

The Susitna River Delta area (including the Beluga and Little Susitna rivers) has become their core summer habitat, with additional high use areas in Knik and Turnagain Arms. Little is known about late fall, winter, or early spring habitat use, although we know that beluga whales make use of the Kenai River when salmon runs (and various salmon fisheries) are not underway. Coastal development, especially near Anchorage, has the potential to disrupt beluga whale behavior, and may alter movements among important summer habitat patches through acoustic disruption (e.g., pile driving may hinder passage to or from Knik Arm from the Susitna Delta area). Boat traffic in the Twentymile River has been documented as having caused behavioral disruption of beluga whales present in the river, while they were presumably feeding there, but fled the river channel to Turnagain Arm when boats encountered them. Seismic exploration in upper Cook Inlet has caused both Level A and Level B takes of Cook Inlet beluga whales. We have no data indicating whether other vessel activities, such as commercial shipping, have caused acoustic harassment of these belugas. Aircraft have been observed to cause behavioral changes in feeding groups of Cook Inlet beluga whales in the Susitna Delta when aircraft circled those groups.

Cook Inlet belugas are undergoing an annual decline of 0.4 percent (Shelden et al. 2015). Threats associated with resource development activities such as oil and gas development were considered a factor in the decision to list the species as endangered, but the best available information indicated that these activities were not likely a major contributing factor in the population's decline that preceded the listing (73 FR 62919; October 22, 2008). Oil and gas development in Cook Inlet remains a concern regarding the recovery of the DPS; however, little is known regarding how possible threats, alone or cumulatively, are impacting recovery of the Cook Inlet beluga whale DPS.

Pollution and contaminants were listed as low relative concern for impeding the recovery of Cook Inlet beluga whales (NMFS 2016d, Muto et al. 2017b). For the contaminants that have been studied, Cook Inlet beluga whales generally had lower contaminant loads than did beluga whales from other populations (Becker et al. 2000, Lebeuf et al. 2004, NMFS 2008a, Becker 2009, DFO 2012, Reiner et al. 2011, Wetzel et al. 2010, Hoguet et al. 2013). Only one known beluga whale mortality associated with fisheries interaction was reported in over 10 years. There is no current subsistence harvest of Cook Inlet beluga whale (Muto et al. 2017b).

Due to the location of the lease area, as well as implementation of mitigation measures, exposures to noise at received levels that could cause harassment to listed species are expected to be minimal. Effects of this action would have been greater on Cook Inlet beluga whale had the lease sale been located further to the north. Data we have presented suggest that beluga whales are almost entirely absent from the LS 244 area during summer months but are present at low densities at the northern and western fringes of the LS244 area fall and winter. Mitigation measures will reduce exposure of listed species to loud noise from the action through project timing, and by putting into place measures that facilitate early detection of approaching marine mammals and reduction of acoustic output if marine mammals appear likely to enter associated disturbance zones.

Fin, Mexico DPS humpback, and Western North Pacific DPS humpback whales occur in low densities in Cook Inlet, primarily during the ice-free season.

Although seismic exploration, impact pile driving, drilling, and towing activities are likely to cause individual whales to experience changes in their behavioral states that might have adverse consequences (Frid and Dill 2002b), these responses are not likely to alter the physiology, behavioral ecology, or social dynamics of individual whales in ways or to a degree that would reduce their fitness.

During future incremental steps, a low probability, high impact event involving an unauthorized large oil spill where large numbers of whales might experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality that exceeds PBR (zero for Cook Inlet beluga whales, 3 for Western North Pacific DPS humpback whales, unknown for Mexico DPS humpback whales, and 2.1 for fin whales).

The hypothetical exploration and development scenario estimates a 22% likelihood of 1-2 large oil spills or gas releases if the assumed 215 million barrels of oil and natural gas are developed and produced between years 6-40 (BOEM 2017b). No VLOS is expected (the estimated probability is $10^{-4} – 10^{-5}$ per well; see BOEM 2016b) based on historical occurrence and low number of activities being authorized. Based on these factors, the risk of significant long term exposures of whales to accidental discharges of oil is low. The other stressors associated with future incremental steps are anticipated to have similar effects to those discussed during the first incremental step. Therefore, based on the best information currently available, the effects of future incremental steps, including development, production, and decommissioning activities, on LS 244 in Cook Inlet are not reasonably likely to jeopardize the continued existence or appreciably reduce the likelihood of recovery of Cook Inlet beluga, fin, Mexico DPS humpback, or Western North Pacific DPS humpback whales.

8.2 Western DPS Steller Sea Lion Risk Analysis

Based on the results of the *Exposure Analysis*, during the first incremental step, we expect western DPS Steller sea lions may be taken due to seismic noise, drilling noise, pile driving noise, and rig movement noise associated with the oil and gas exploration activities based on scenarios provided by BOEM/BSEE associated with the first incremental step. Exposure to vessel noise from transit, aircraft noise, noise from non-seismic geohazard surveys, seafloor disturbance, and small oil spills may occur but are considered minimal effects and would not rise to the level of take. Exposure to vessel strike is extremely unlikely to occur. One Steller sea lion was reported from within the action area with two separate head wounds consistent with blunt trauma, with suspected vessel strike as the cause of the trauma (NMFS Alaska Regional Office Stranding Database accessed May 2017). There are no other reported vessel collisions or prop strikes of Steller sea lions in Cook Inlet. The incremental increase in ship traffic due to this first incremental step is unlikely to change this pattern markedly. Therefore, we consider the likelihood of additional strikes resulting from this action to be very improbable. Exposure to nonbiodegradable marine debris, specifically to debris that can cause entanglement, remains an unquantifiable risk, but not one that will cause jeopardy to western DPS Steller sea lions. Best practices regarding waste management (cutting loops prior to disposal) will further reduce the impact of debris on Steller sea lions. Because the probability of large and very large oil spills are considered extremely unlikely to occur, the effects from those events are also considered improbable. Finally, large and very large oil spills are considered low probability, high-impact events (see Section 6.1.3).

The effects to western DPS Steller sea lions associated with pile driving, aircraft traffic, drilling operations, and small oil spills during future incremental steps (development, production, and decommissioning) are anticipated to be similar to those effects described for Steller sea lions during the first incremental step, but with increased sound exposures and risk of spills due to increased vessel and aircraft traffic, drilling operations, and pipeline installation. Mitigation measures required for pile driving would further reduce the impacts to listed sea lions (BOEM 2017b). The risk of spills associated with large oil spills is anticipated to significantly increase during future incremental steps due to the increase of activities. BOEM estimates a 22% chance of one or more large spills occurring (1,700 – 5,100 bbl) over the life of the project, with a far smaller chance that this spill will occur during the first incremental step, prior to the establishment of production wells. No VLOS is expected ($>10^{-4}$ to $<10^{-5}$ per well frequency of occurrence). The effects of a large oil spill would be significantly greater than small spills. A low probability, high impact circumstance where large numbers of sea lions experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality that exceeds PBR. However, due to the low likelihood of multiple large oil spills, and even lower predicated likelihood of a VLOS, the risk of significant long term exposures of sea lions to accidental discharges of oil is low. In addition, a number of regulatory changes have been put in place since Deepwater Horizon in an effort to reduce the risk of spills associated with oil and gas exploration and development activities.

The primary mechanism by which the behavioral changes we have discussed affect the fitness of individual animals is through the animal's energy budget, time budget, or both (the two are related because foraging requires time). Most adult Steller sea lions occupy rookeries during the pupping and breeding season, which extends from late May to early July (NMFS 2008a). While the pupping and breeding season overlaps with the proposed action activities, no Steller sea lion rookeries or haulouts are within the LS 244 area, although 12 major haulouts and 1 major rookery that are part of designated Steller sea lion critical habitat (50 CFR §226.202(a) and Tables 1 and 2 to 50 CFR Part 226) and part of one special aquatic foraging area designated as critical habitat (50 CFR §226.202(c)(1)) are within the action area. High concentrations of Steller sea lions occur in and around lower Cook Inlet, in areas south of the LS244 parcels, but within the southern portions of the action area potentially impacted by vessel movements, spills, and pollution. However, the individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of Steller sea lions. As a result, the Steller sea lions' probable responses (i.e., tolerance, avoidance, short-term masking, and short-term vigilance behavior) to close approaches by vessel operations and their probable exposure to noise from pile driving, drilling, and seismic are not likely to reduce their current or expected future reproductive success or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of these rates) of the population those individuals represent.

In total, the proposed action is anticipated to result in 1,282 instances of take of western DPS Steller sea lions at received sound levels ≥120 dB re 1 μPa rms for continuous noise sources and ≥160 dB e 1 μPa rms for impulsive noise sources during oil and gas exploration activities (Table 18), if jack-up drill rigs are used. However, if drillships are used, then we estimate take to be about 2,452 western DPS Steller sea lions (Table 19).

No exposures of western DPS Steller sea lions to these noise sources are anticipated to result in TTS or PTS. These estimates represent the total number of takes that could potentially occur, not necessarily the number of individuals taken, as a single individual may be "taken" multiple times over the course of the proposed action (here, the first incremental step, years 1-5). These take estimates are likely to be overestimates because the estimates assume a uniform distribution of animals, do not account for avoidance or the effectiveness of mitigation measures, and assume all of the activities associated with the first incremental step will be implemented (see Tables 17-19). Mitigation measures will reduce exposure of listed species to loud noise from the action through project timing, and by putting into place measures that facilitate early detection of approaching marine mammals and reduction of acoustic output if marine mammals appear likely to enter associated disturbance zones.

Exposure to non-tug vessel noise from transit, aircraft noise, noise from non-seismic geohazard surveys, seafloor disturbance (including geotechnical surveys), and small oil spill discharge may occur as part of the proposed action, but are considered minor and would not rise to the level of take. Exposure to vessel strike is extremely unlikely to occur. We have records suggesting that one Steller sea lion was likely killed by a vessel strike within the action area. The incremental increase in ship traffic due to this first incremental step is unlikely to change this pattern markedly. Therefore, we consider the likelihood of additional strikes resulting from this action to be very improbable. Exposure to nonbiodegradable marine debris, specifically to debris that can cause entanglement, remains an unquantifiable risk, but not one that will cause jeopardy to western DPS Steller sea lions. Best practices regarding waste management (cutting loops prior to disposal) will further reduce the impact of debris on Steller sea lions. Large and very large oil spills are considered low probability, but high impact events during the first incremental step (years 1-5) (see Sections 6.1.3.2 through 6.1.3.9).

Based on the localized nature of small oil spills, the relatively rapid weathering expected for <1,000 bbl of oil, the small number of refueling activities in the proposed action, and the safe guards in place to avoid and minimize oil spills, we conclude that the probability of a BOEM/BSEE authorized activity within the first incremental step causing a small oil spill and exposing western DPS Steller sea lions on LS 244 in Cook Inlet sufficiently small as to be extremely unlikely to occur, and thus the effects are considered improbable. If exposure were to occur, due to the ephemeral nature of small, refined oil spills, NMFS does not expect detectable responses from sea lions from small oil spills and we would consider exposure minimal during the first incremental step of the proposed action.

For seismic, rig towing, drilling, and pile driving, PSOs are required. However, drilling and mud pumping operations do not have the ability to shut down if marine mammals enter the harassment zone. While this will not mitigate the potential impacts associated with drilling operations, PSOs will ensure the harassment zone (330 m) is clear of marine mammals prior to drilling commencing. Considering that this will be a continuous source of underwater noise, it is not anticipated that marine mammals would enter into an area where they would suffer from acoustic harassment. However, they may deflect around the area.

Western DPS Steller sea lions occur in the LS 244 area at low densities, but may occur there throughout all months of project activity as a result of year-round presence on or around nearby rookeries and haulouts. We used the Jacobs Engineering (2017) raw density estimates for

Furie's project for all of our exposure estimates related to components of this action because of the closer proximity of this to concentrations of Steller sea lions (compared to Furie's Kitchen Lights unit further north in Cook Inlet).

Oil and gas exploration activities are likely to cause some individual Steller sea lions to experience changes in their behavioral states that might have adverse consequences (Frid and Dill. 2002). However, it remains unknown whether these responses are likely to alter the physiology, behavioral ecology, or social dynamics of individual Steller sea lions in ways or to a degree that would reduce their fitness. While a single individual may be exposed to harassing levels of sound from the same or multiple sources multiple times over the course the proposed action, the implementation of mitigation measures to reduce exposure to high levels of seismic sound reduce the likelihood of exposure to action-related noise capable of affecting vital life functions or causing TTS or PTS. In most circumstances, we assume Steller sea lions are likely to avoid ensonified areas that may cause TTS or PTS. Steller sea lions that avoid these sound fields or encounter them briefly are not likely to experience significant disruptions of their normal behavior patterns. Southall et al. (2007) reviewed literature describing responses of pinnipeds to continuous sound and reported that the limited data suggest exposures between ~90 and 140 dB re 1 μPa generally do not appear to induce strong behavioral responses in pinnipeds exposed to continuous sounds in water.

The strongest evidence supporting the conclusion that exploration activities will likely have minimal impact on western DPS Steller sea lions is the growth of this population, especially in the eastern portion of its range, which includes the most heavily trafficked portions of critical habitat. The endangered western DPS Steller sea lion population is increasing at ~2 percent per year (between 2000 to 2015) throughout its range (Muto et al. 2017b). In the region of this project, the population of non-pups is increasing at 2.68 percent per year, while the number of pups counted are increasing at 2.82 percent per year from 2000-2015 (Muto et al. 2017b), despite the killing or serious injury of an estimated 307 animals per year. Between 2010 and 2014, a mean annual mortality and serious injury rate of 30 animals is due to federally-regulated commercial fishing. An estimated 15 western DPS animals/year were killed or seriously injured by state-managed fisheries when these fisheries were observed in 1990-1991. NMFS stranding database indicates an additional 1.6 western DPS animals were killed or seriously injured in 2010-2014 due to interaction with commercial fishing gear from unknown fisheries and 3.0 western DPS animals per year were killed or seriously injured due to non-fishery-related and non-subsistence-related causes during that same time period. An estimated 230 animals are harvested each year for subsistence use.

As we discussed in the *Approach to the Assessment* section of this opinion, an action that is not likely to reduce the fitness of individual sea lions would not be likely to reduce the viability of the population those individual sea lions represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of the western DPS). For the same reasons, an action that is not likely to reduce the viability of the population is not likely to increase the extinction probability of the species; in this case, the western DPS Steller sea lion. As a result, the leasing and exploration activities BOEM and BSEE plan to authorize during the first incremental step on LS 244 are not likely to appreciably reduce the western DPS Steller sea lion's likelihood of surviving or recovering in the wild.

During future incremental steps, a low probability, high impact circumstance where large numbers of sea lions experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality that of a substantial number of individuals. However, due to the low likelihood of multiple large oil spills, and even lower predicated likelihood of a VLOS, the risk of significant long term exposures of sea lions to accidental discharges of oil is low. The other stressors associated with future incremental steps are anticipated to have similar effects to those discussed during the first incremental step. Therefore, based on the best information currently available, the effects of future incremental steps, including development, production, and decommissioning activities on LS 244 in Cook Inlet are not reasonably likely to jeopardize the continued existence or appreciably reduce the likelihood of recovery in western DPS Steller sea lions.

8.3 Critical Habitat Risk Analysis (Cook Inlet Beluga and Steller Sea Lion)

As described in the *Status of the Species and Critical Habitat* (Section 4), designated critical habitat for the Cook Inlet beluga includes five PBFs essential to the conservation of the species: intertidal and subtidal waters of Cook Inlet with depths <30 feet and within five miles of high and medium flow anadromous fish streams; primary prey species; waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales; unrestricted passage within or between critical habitat areas; and waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales (50 CFR §226.220(c)). Lease blocks overlap with Critical Habitat Area 2. Critical Habitat Area 2 supports dispersed fall and winter feeding and transit areas. Even if a large oil spill were to occur, spill trajectories analyzed a less than 6% chance of oil reaching the Forelands (BOEM 2017b).

Steller sea lion critical habitat includes five PBFs including: terrestrial zones that extend 3,000 feet (0.9 km) landward from each major haulout and major rookery in Alaska; air zones that extend 3,000 feet (0.9 km) above the terrestrial zone of each major haulout and major rookery in Alaska; aquatic zones that extend 3,000 feet (0.9 km) seaward of each major haulout and major rookery in Alaska that is east of 144^{o} W longitude; aquatic zones that extend 20 nm (37 km) seaward of each major haulout and major rookery in Alaska that is west of 144^{o} W longitude; and three special aquatic foraging areas (Shelikof Strait area, the Bogoslof area, and the Seguam Pass area) (50 CFR §226.202). Within the action area, terrestrial, air, and aquatic zones out to 20 nm, and Shelikof Strait foraging area may overlap with oil spill and vessel traffic. However, no critical habitat is located within the lease blocks in the LS 244 area (BOEM 2017b).

The primary threats that could affect the features identified as essential to conservation of Steller sea lions include: wildlife viewing, boat and aircraft traffic, research activities, commercial, recreational and subsistence fishing, timber harvest, hard mineral extraction, oil and gas development, coastal development, including pollutant discharges, and subsistence harvest. The primary threats that could affect the features identified as essential to conservation of Cook Inlet beluga whales were not addressed in the final rule designating critical habitat, but the recovery plan lists threats to both the species and its critical habitat. Threats to beluga whales of high and medium concern that may impact critical habitat include: catastrophic events such as oil spills, noise, habitat loss or degradation, and reduction in prey.

The overall functioning of essential habitat features in the action area appears to be relatively high. Continued increases in Steller sea lions in the eastern Aleutians, Alaska Peninsula, and

Southcentral Alaska suggest that habitat in these areas is currently capable of supporting more animals than it currently does. For Cook Inlet beluga whales, the functioning of essential features is less clear. The beluga population continues to decline slowly despite the removal of the threat that was assumed to have been the primary cause of the dramatic decline during the 1990s. While petroleum spills remain a low risk event, with all else equal, the probability of a catastrophic spill increases as oil and gas development increases. This action portends such an increase in oil and gas development within the action area. In-water noise in upper Cook Inlet is likely increasing, but noise trends throughout the action area are unknown. Cook Inlet is not classified as an impaired water body, but the reason for this classification is that adequate water quality information is lacking. Although belugas may have abandoned critical habitat off of the Kenai River during summer salmon runs, they make heavy use of salmon runs elsewhere in Upper Cook Inlet, where abundance and trends in salmon returns remain largely unknown. This first incremental step associated with LS 244 is not expected to measurably affect salmon returns within the action area, nor is it expected to have more than a minimal impact upon other PBFs for Cook Inlet beluga whale critical habitat.

The proposed action may cause physical and acoustic effects which could alter the quality of the essential features of designated critical habitat, or render portions of it temporarily unsuitable. While noise impacts are not anticipated to result in abandonment of designated critical habitat, noise could temporarily make the prey features near the seismic and drilling operations less suitable to beluga whale foraging. The noise effects could last as long as the operations are occurring (~30-90 days for seismic exploration and 30-180 days for drilling). No drilling or seismic operations are anticipated to overlap with designated Steller sea lion critical habitat, as no lease blocks are located within Steller sea lion critical habitat. However, transiting vessels may overlap with aquatic zones.

We anticipate that anchor handling, dynamic positioning, rig towing, and vessel operations will have minor effects on designated critical habitat.

As part of the proposed action, BOEM/BSEE will not authorize seismic surveys on within LS 244 between November 1 and April 1, nor will they occur on OCS blocks containing beluga whale nearshore feeding areas between July 1 and September 30. Geohazard and geotechnical surveys will not occur on beluga whale critical habitat OCS blocks between November 1 and April 1. Exploration and delineation drilling will not occur on OCS blocks within Cook Inlet beluga whale critical habitat between November 1 and April 1. Finally, no seismic, geohazard, or geotechnical surveys will be allowed above Anchor Point from about mid-June to mid-August (BOEM 2017b). However, waivers to these stipulations may be obtained from BOEM. These time and area restrictions will reduce impacts to beluga whale winter feeding habitat during the times of year that belugas will most likely be using those habitats. They will also reduce impacts to salmon populations that are migrating towards their spawning streams.

Small spills are not expected to have a measurable impact upon beluga whale or Steller sea lion critical habitat because they are expected to evaporate, degrade, and disperse prior to impacting that habitat. BOEM estimates a 22% chance of one or more large spills occurring over the life of the project. No very large oil spills are expected ($>10^{-4}$ to $<10^{-5}$ per well frequency of occurrence) (BOEM 2017b). If a large spill were to occur, it could significantly impact Cook Inlet beluga designated critical habitat at any time of the year, by introducing toxin and other harmful agents in amounts harmful to beluga, and/or by contaminating/destroying food resources, another essential feature. Steller sea lion designated haulouts, rookeries, and aquatic zones, and foraging areas may be impacted. However, a large oil spill would still be localized to a portion of the overall habitat. One large oil spill will not likely adversely modify designated critical habitat due to the relatively small proportion of the habitat that would be impacted, the temporary nature of oil in water or ice, and cleanup and response activities.

Four environmental resource areas relevant to Cook Inlet beluga critical habitat may be exposed if a large oil spill were to occur. These areas are vulnerable year round. A large spill or VLOS could disrupt access to designated critical habitat, which is another PBF (BOEM 2017b).

All twenty-one Steller sea lion environmental resource areas in and near Cook Inlet occur within designated critical habitat. Shelikof foraging area and Barren Islands have the highest probability (<25%) of a large or very large oil spill contacting them (BOEM 2017b).

Depending on the size and scale of a spill, it could require multiple seasons to return the essential features to their original quality. Areas within the pathway of the spill would be most impaired while areas outside of the pathway would be affected less. The essential feature of primary prey resources for both Steller sea lions and Cook Inlet beluga would likely take longer to recover from a large or very large spill, due to potential effects on prey populations and reproduction (BOEM 2017b).

A very large oil spill in Cook Inlet has the potential to adversely modify designated critical habitat if it were to occur. A very large oil spill could affect an area extending across a major portion of the lower and middle Cook Inlet. A large or very large oil spill is not expected to extend north into Cook Inlet beluga whale critical habitat area 1 in the upper inlet. While strong winds and strong tides could result in some product from a very large oil spill extending north of the Forelands, the net outflow of inlet waters from freshwater inputs in upper Cook Inlet are expected to preclude such incursions of spilled oil into this area. The impacts to the designated critical habitat for Cook Inlet beluga whales could be at a level that destroys the value of the habitat for multiple years to a degree that a significant proportion of the Cook Inlet beluga whale DPS is not able to successfully reproduce or survive, risking the recovery or stability of the DPS. Population level effects to Steller sea lion may be minor to severe depending on timing and location of a spill. However, BOEM estimates that the chance of a VLOS occurrence is extremely low due to a number of factors, including historical occurrence, limited number of activities being authorized, and safety measures in place (BOEM 2017b). Based on likelihood, NMFS concludes that oil spills resulting from the first incremental step of the proposed action are likely to be small spills of refined petroleum products. These products are expected to evaporate, weather, and dissipate before causing any measurable effect to either Cook Inlet beluga or Steller sea lion critical habitat. Oil spills that may occur during future incremental steps are more likely to be large and composed of crude oil, with the potential to cause more serious adverse effect to critical habitat. However, due to the low predicted likelihood of large or VLOS, oil spills resulting from future incremental steps are not likely to adversely modify designated critical habitat.

Based on our analyses of the evidence available, the quantity or availability of the essential features of critical habitat are not likely to decline as a result of being exposed to oil and gas exploration activities during the first incremental step, or activities associated with future incremental steps. Disturbance consisting of both physical and acoustic effects could temporarily alter the quality of the essential features for both Cook Inlet beluga whale and Steller sea lion critical habitats, but there is less potential for overlap with Steller sea lion critical habitat. In addition, due to the low number of vessels being authorized, the limited use of towing rigs, the limited overlap with beluga whale critical habitat Area 2, the lack of Steller sea lion critical habitat in the lease area, the low probability of spill, the size and quality of the remaining habitat, the high tolerance of pinnipeds to drilling and seismic operations, the temporary impact to prey resources, and the application of standard mitigation measures to avoid adverse impacts, we conclude that the proposed action is not likely to destroy or adversely modify the designated critical habitat for either Cook Inlet beluga whales or Steller sea lions.

9 CONCLUSION

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Cook Inlet beluga whale (*Delphinapterus leucas*), fin whale (*Balaenoptera physalus*), Western North Pacific DPS of humpback whale (*Megaptera novaeangliae*), Mexico DPS humpback whale (*Megaptera novaeangliae*), or western DPS Steller sea lion (*Eumetopias jubatus*).

In addition, the proposed action is not likely to destroy or adversely modify the designated critical habitat for Steller sea lions or Cook Inlet beluga whales.

10 INCIDENTAL TAKE STATEMENT

NMFS recently promulgated changes to the section 7(a)(2) implementing regulations (80 FR 26832, May 11, 2015; ITS rule) that state an Incidental Take Statement is not required at the programmatic level for framework programmatic actions where information on the specific number, location, timing, frequency, and intensity of actions is unknown, and any incidental take resulting from any actions subsequently authorized, funded, or carried out under the program will be addressed in separate ESA section 7 consultations (see 50 CFR §402.14(i)(6)). A framework programmatic action means, for purposes of an incidental take statement, a Federal action that approves a framework for the development of future action(s) that are authorized, funded, or carried out at a later time, and any take of a listed species would not occur unless and until those future action(s) are authorized, funded, or carried out and subject to further section 7 consultation (50 CFR §402.02).

Lease Sale 244 in and of itself will not affect marine mammals and will not alone result in the incidental take of marine mammals (80 FR 26832, 26835; May 11, 2015). However, if blocks are leased in the sale, the subsequent authorization of geological and geophysical exploration permits, ancillary activities, exploration plans, permits to drill, and development and production plans may affect listed species and require BOEM and BSEE to initiate project-specific consultation associated with the issuance of Marine Mammal Protection Act Incidental Harassment Authorizations or Letters of Authorization. In addition, subsequent authorizations at the exploration stage, including G&G permits, exploration plans, and a permit to drill, may affect listed species and may require BOEM and BSEE to initiate project-specific consultation for specific actions under this first incremental step. If commercially recoverable reserves are found and are proposed for development, BOEM and BSEE also may initiate consultation on future incremental steps associated with development, production, and decommissioning activities that affect listed species. Therefore, consultation will be required for all activities related to the LS244 program that may affect listed species. For each subsequent consultation, NMFS will determine whether a future activity under this program is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of the critical habitat of such species.

At each step under this program (LS 244), project-specific information will aid in the assessment of effects on listed species and the amount and extent of incidental take resulting from that project; project-specific information also will aid in the development of sufficiently specific and meaningful terms and conditions for each project and will ensure an accurate and reliable trigger for reinitiation of consultation (80 FR 26832, 26835-36; May 11, 2015). In addition to the mitigation measures provided in this opinion, additional mitigation measures may be included in subsequent section 7 consultations.

NMFS will compare the effects of project-specific actions and associated take levels to the effects anticipated under this overarching LS 244 opinion. If the amount or extent of incidental take that is proposed to be authorized through individual projects exceeds the levels estimated and analyzed here, or if the project-specific effects on the listed species or designated critical habitat will occur in a manner or to an extent not considered in this opinion, reinitiation of consultation on the LS 244 biological opinion will be required.

11 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR §402.02).

1. BOEM/BSEE should ensure that crew are instructed in marine mammal identification and are instructed to keep watch for them and report their presence whenever feasible.
2. BOEM/BSEE should ensure that all synthetic materials are kept out of marine waters, and that packing straps and other plastic or fibrous loops are cut prior to being discarded.
3. BOEM/BSEE should implement the following measures to help standardize the Protected Species Observer Program (Baker et al. 2013):
    - Implement standardization for data collection methods, electronic forms, and software used in collaboration with NMFS and non-federal stakeholders;
    - Develop permits or agreements detailing expectations and data collection and reporting of third-party PSO provider companies, including performance standards, conflicts of interest, and standards of conduct;
    - Implement quality assurance standards and submit PSO data for annual data analysis;
    - Establish a process to advertise for and approve PSO procedures;
    - Hold a stakeholder workshop to discuss new PSO procedures;
    - Develop a mechanism, procedure, or regulation to ensure that selected PSO providers are being compensated prior to deployment of approved observers;
    - Develop a debriefing and evaluation system for observers.
4. Under the BOEM Environmental Studies Program, consider studies specifically designed to assess the effects of oil and gas activities on Cook Inlet beluga whales in mid to lower Cook Inlet, including winter distribution studies and assessment of prey contaminant loads.
5. Work with NMFS and other resource agencies to track oil and gas spills/releases into Cook Inlet associated with the proposed action, and implement timely response in open-water and in-ice conditions.

In order to keep NMFS's Protected Resources Division informed of actions minimizing or avoiding adverse effects, or benefitting listed species or their habitats, BOEM/BSEE should notify NMFS of any conservation recommendations they implement.

12 REINITIATION OF CONSULTATION

As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion, including the granting of waivers to lease stipulations, or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount of incidental take is exceeded, section 7 consultation must be reinitiated immediately.

13 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act (DQA)) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

13.1 Utility

This document records the results of an interagency consultation. The information presented in this document is useful to NMFS, BOEM and BSEE, and the general public. These consultations help to fulfill multiple legal obligations of the named agencies. The information is also useful and of interest to the general public as it describes the manner in which public trust resources are being managed and conserved. The information presented in these documents and used in the underlying consultations represents the best available scientific and commercial information and has been improved through interaction with the consulting agency.

This consultation will be posted on the NMFS Alaska Region website: http://alaskafisheries.noaa.gov/pr/biological-opinions/. The format and name adhere to conventional standards for style.

13.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, ‘Security of Automated Information Resources,’ Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

13.3 Objectivity

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the ESA Consultation Handbook, ESA Regulations, 50 CFR Part 402.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the literature cited section. The analyses in this opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data, and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA implementation, and reviewed in accordance with Alaska Region ESA quality control and assurance processes.

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