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

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion

Hilcorp Alaska and Harvest Alaska Oil and Gas Activities, Cook Inlet, Alaska

NMFS Consultation Number: AKRO-2018-00381

Action Agency: National Marine Fisheries Service (NOAA), Office of Protected Resources, Permits and Conservation Division; and Bureau of Ocean Energy Management (BOEM)

Affected Species and Determinations:

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

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By: Robert D Mecum for

James W. Balsiger, Ph.D.
Regional Administrator

Date: June 18, 2019

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TERMS AND ABBREVIATIONS

μPa	Micro Pascal
2D	Two-Dimensional
3D	Three-Dimensional
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOT&PF	Alaska Department of Transportation and Public Facilities
AFSC	Alaska Fisheries Science Center
AGDC	Alaska Gasline Development Corporation
AGL	Above Ground Level
AOGCC	Alaska Oil and Gas Conservation Commission
APDES	Alaska Pollution Discharge Elimination System
ARRC	Alaska Railroad Corporation
AW	Arctic Wolf
AWTF	Asplund Wastewater Treatment Facility
AWWU	Anchorage Wastewater Utility
Bbl	Barrels
BIA	Biologically Important Area
BLM	Bureau of Land Management
BMP	Best Management Practices
BOEM	Bureau of Ocean Energy Management
BOP	Blowout preventer
BSEE	Bureau of Safety and Environmental Enforcement
C	Celcius
CI	Confidence Interval
CISPRI	Cook Inlet Spill Prevention and Response, Inc.
CITES	Convention on International Trade in Endangered Species
cm	centimeter
CO2	Carbon dioxide
cui	Cubic Inches
CV	Coefficient of Variance
CWA	Clean Water Act
dB re 1μPa	Decibel referenced 1 microPascal
DOG	Division of Oil and Gas
DP	Dynamic Positioning
DGPS/RTK	Differential Global Positioning System/roving units
DPH	Detection Positive Hours
DPS	Distinct Population Segment
DQA	Data Quality Act
DSV	Dive support vessel
EIS	Environmental Impact Statement
EMALL	ExxonMobil Alaska LNG LCC
EPA	Environmental Protection Agency
EPOC	Emerging Pollutants of Concern
ESCA	Endangered Species Conservation Act
ESA	Endangered Species Act
EUR	Estimated Ultimate Recoveries

EZ	Exclusion Zone
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
ft	feet
G&G	Geological & Geophysical
GPTF	Granite Point Tank Farm
HDD	Horizontal Directional Drilling
HF	High frequency
Hz	Hertz
ID	identification
IHA	Incidental Harassment Authorization
in	inch
INS	Integrated navigation system
ITR	Incidental Take Regulations
ITS	Incidental Take Statement
IUCN	International Union for Conservation of Nature
JBER	Joint Base Elmendorf-Richardson
kg	kilogram
kHz	kilohertz
KLU	Kitchen Lights Unit
km	Kilometers
kn	Knot
KNWR	Kenai National Wildlife Refuge
km2	Square Kilometers
L	Liters
Le	Exposure level
LF	Low frequency
LNG	liquefied natural gas
LOC	Letter of Concurrence
m	Meter
MF	Mid-frequency
mgd	Million gallons per day
MGSOF	Middle Ground Shoal Onshore Facility
mi	Mile
ms	milliseconds
MMPA	Marine Mammal Protection Act
MPI	Magnetic particle inspection
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
OCS	Outer Continental Shelf
Opinion	Biological Opinion
ORPC	Ocean Renewable Power Company
OSK	Offshore Systems Kenai
OSRA	Oil Spill Risk Analysis
OTS	Over the side
OW	Otariid pinnipeds
P&A	Plugged and abandoned
PDO	Pacific Decadal Oscillation

PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PBF	Physical or Biological Features
PCB	Polychlorinated Biphenyls
PCE	Primary Constituent Element
PF	Peregrine Falcon
PHMSA	Pipeline and Hazardous Materials Safety Administration
PK	Peak sound level
POA	Port of Alaska [previously “Port of Anchorage”]
ppm	Parts per million
psi	Pound Per Square Inch
PSO	Protected Species Observers
PTS	Permanent Threshold Shift
PW	Phocid pinnipeds
RA	Rope access
rms	Root Mean Square
RPA	Reasonable Prudent Alternative
SAE	SAExploration, Inc.
SCA	secondary containment area
SUDEX	Susitna Delta Exclusion Zone
TBPF	Trading Bay Production Facility
TSAIA	Ted Stevens Anchorage International Airport
TTS	Temporary Threshold Shift
UAS	Unmanned aerial systems
UME	Unusual Mortality Event
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDOT	United States Department of Transportation
USFWS	United States Fish and Wildlife Service
UT	Ultrasonic testing
VHF	Very high frequency
VSP	Vertical Seismic Profiling
WMS	Public Works
WW	Westward Wind

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)).

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 to minimize such impact, and sets forth terms and conditions to implement those measures.

In this document, the action agencies are NMFS Office of Protected Resources, Permits and Conservation Division (hereafter referred to as "the Permits Division") and Bureau of Ocean Energy Management (BOEM). The Permits Division plans to issue 5-year (2019-2024) incidental take regulations (ITR) pursuant to section 101(a)(5)(A) of the Marine Mammal Protection Act of 1972, as amended (MMPA) (16 U.S.C. 1361 et seq.), to Hilcorp Alaska, LLC (Hilcorp) and Harvest Alaska, LLC (Harvest; hereinafter referred to together as "Hilcorp") for harassment of marine mammals incidental to the proposed action. BOEM plans to issue a 1-year (August 1, 2019 to August 1, 2020) geological and geophysical permit for Hilcorp's seismic surveys in Cook Inlet. The consulting agency for this proposal is NMFS's Alaska Regional Office. This document represents NMFS's biological opinion (opinion) on the effects of this proposal on endangered and threatened species and designated critical habitat.

The opinion and incidental take statement were prepared by NMFS Alaska Region (AKR) in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR 402. The opinion and ITS are in compliance with the Data Quality Act (44 U.S.C. 3504(d)(1) *et seq*.) and underwent pre-dissemination review.

1.1 Background

This opinion considers the effects of Hilcorp's oil and gas exploration, development, production, and decommissioning activities in Cook Inlet, Alaska between June 1, 2019 and June 1, 2024. These actions have the potential to affect endangered Cook Inlet beluga whales (*Delphinapterus leucas*), endangered fin whales (*Balaenoptera physalus*), endangered Western North Pacific distinct population segment (DPS) humpback whales (*Megaptera novaeangliae*), threatened Mexico DPS humpback whales, endangered Western DPS Steller sea lions (*Eumetopias* *jubatus*), and designated critical habitat for Cook Inlet beluga whales and Steller sea lions. Take would occur by Level A and Level B harassment incidental to a variety of sources including: 2D and 3D seismic surveys, geohazard surveys, vibratory sheet pile driving, and drilling of exploratory wells.

This opinion focuses on Hilcorp's activities for the next five years (2019-2024); however, we recognize that a portion of these activities (e.g., maintenance, production, etc.) may continue after 2024, potentially 30 years into the future, and our analysis has included this assumption.

This opinion is based on information provided in Hilcorp's petition for incidental take regulations (ITR; (Hilcorp 2019)), Proposed Regulations (84 FR 12330), the Biological Assessment (Hilcorp 2018), the updated project proposals, email and telephone conversations between NMFS Alaska Region and NMFS Permits Division 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

- **April 17, 2018:** Hilcorp submitted the initial draft of the ITR petition to NMFS Permits Division.
- **May 24, 2018:** Hilcorp submitted a Biological Assessment to NMFS Permits Division and NMFS AKR.
- **June 28, 2018:** Hilcorp submitted a revised petition for ITR to NMFS Permits Division.
- **August 1, 2018:** Hilcorp submitted a revised Biological Assessment to NMFS Permits Division and NMFS AKR. The BA was revised to be consistent with the revised ITR sent June 28, 2018.
- **September 29, 2018**: Hilcorp submitted a revised petition for ITR to NMFS Permits Division and the application was deemed complete.
- **October 4, 2018:** Hilcorp submitted a revised petition for ITR to NMFS Permits Division.
- **December 3, 2018**: NMFS Permits Division requested initiation of consultation under ESA Section 7.
- **December 13, 2018:** BOEM requests participation as a co-action agency on the NOAA consultation under the ESA for the Hilcorp / Harvest Alaska 5–year ITR Petition.
- **December 22, 2018 – January 25, 2019**: Communication was on hold due to lapse in appropriations and resulting partial government shutdown.
- **April 1, 2019:** NMFS Permits Division publishes the proposed rule in the Federal Register (84 FR 12330) and NMFS AKR initiated consultation.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

"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). There are no known interdependent or interrelated activities associated with this action. All activities that would not occur but for the action are addressed in this Opinion.

The following description of the proposed action derives primarily from the Biological Assessment (Hilcorp 2018) and Petition for Incidental Take Regulations (Hilcorp 2019) prepared by Hilcorp, and the Proposed Rule (84 FR 12330; April 1, 2019).

2.1.1 Proposed Activities

Hilcorp has been operating in Alaska since 2011, owning interests and operating oil and gas field production facilities located in Cook Inlet (Figure 1) and on the North Slope. In addition, Hilcorp provides operational support to Harvest for Harvest's consolidated gas and oil pipeline systems in the Cook Inlet region. Harvest Alaska was formed in 2014 as a wholly-owned subsidiary of Hilcorp. Throughout its subsidiaries (Cook Inlet Pipeline Company, Kenai Beluga Pipeline, LLC, and Swanson River Oil Pipeline, LLC) and in its own right, Harvest Alaska owns and operates major pipeline systems in Cook Inlet, as well as the Drift River Terminal and the Christy Lee loading platform.

The geographic area of activity covers a total of approximately 10,926 square kilometers (km^2; 2.7 million acres) in Cook Inlet. It includes land and adjacent waters in Cook Inlet including both State of Alaska and OCS waters (Figure 1). The area extends from the north at the Susitna Delta on the west side and Point Possession on the east side of Cook Inlet to southwest of Homer in lower Cook Inlet.

Four stages of activity are analyzed in this opinion including exploration, development, production, and decommissioning activities within Hilcorp's area of operations in and adjacent to Cook Inlet. Because Cook Inlet has had active oil and gas activities for over 60 years, it includes all four stages of activities in different areas. Many of the activities are progressive (i.e., they depend on results and/or completion of the previous activity). This results in some uncertainty in the timing, duration, and complete scope of work for each year of the proposed action. Hilcorp will submit an application to NMFS each year for an LOA with the specific details of the planned work for that year with estimated take numbers using the same assumptions as in the ITR petition. Table 1 summarizes the planned activities within the geographic scope and the following text describes these activities in more detail. This section is organized into two primary areas within Cook Inlet: lower Cook Inlet (south of the Forelands to Homer) and middle Cook Inlet (north of the Forelands to Susitna/Point Possession)

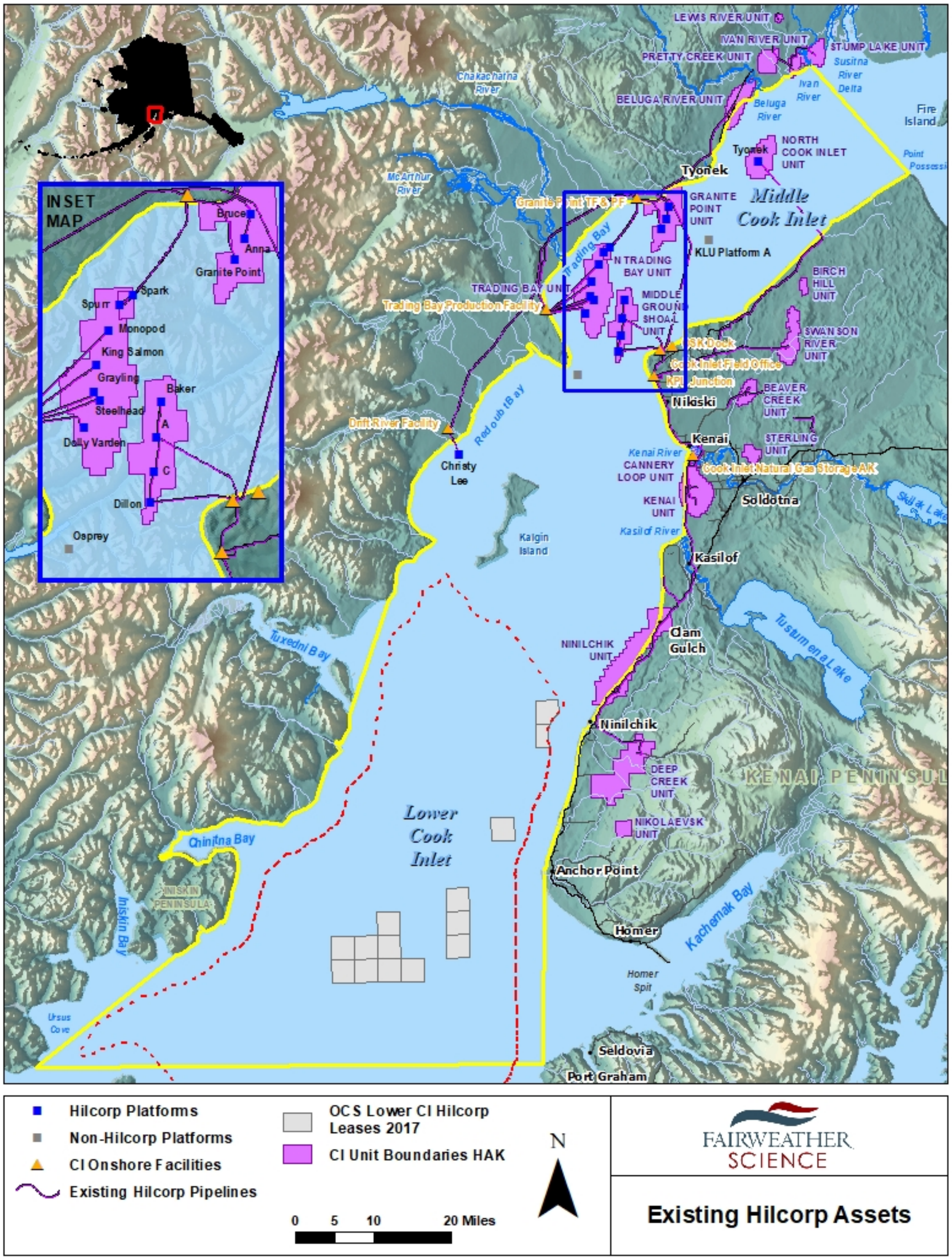

Figure 1. Map showing existing Hilcorp assets in Cook Inlet.

Table 1. Summary of Hilcorp's planned oil and gas activities in Cook Inlet from 2019 through 2024.

Project Name	Cook Inlet Region	Year(s) Planned	Seasonal Timing	Anticipated Duration	Anticipated Noise Sources
Anchor Point 2D seismic survey	Lower Cook Inlet, Anchor Point to Kasilof	2021 or 2022	April-October	30 days (10 days seismic)	Marine: 1 source vessel with airgun array, 1 node vessel Onshore/Intertidal: Shot holes, tracked vehicles, helicopters, 1 mitigation vessel
OCS 3D seismic survey	Lower Cook Inlet OCS	2019 or 2020	April-October	45-60 days	1 source vessel with airgun array, 2 support vessels, 1 mitigation vessel
OCS geohazard survey	Lower Cook Inlet OCS	2019 or 2020	Fall 2019 or spring 2020	30 days	1 vessel with echosounders and/or sub-bottom profilers
OCS exploratory wells	Lower Cook Inlet OCS	2020-2022	February-November	40-60 days per well, 2-4 wells per year	1 jack-up rig[1], drive pipe installation, vertical seismic profiling, 2-3 tugs for towing rig, support vessels, helicopters
Iniskin Peninsula exploration and development	Lower Cook Inlet, west side	2020-2022	April-October	180 days	Construction of causeway, vibratory sheet pile driving, vessels
Platform & pipeline maintenance	Middle Cook Inlet	2019-2024	April-October	180 days (each year)	Vessels, water jets, hydraulic grinders, pingers, helicopters, and/or sub-bottom profilers
North Cook Inlet Unit subseawell geohazard survey	Middle Cook Inlet	2020	April-October	14 days	1 vessel with echosounders and/or sub-bottom profilers
North Cook Inlet Unit well abandonment activity	Middle Cook Inlet	2020	April-October	90 days	1 jack-up rig [1], tugs towing rig, support vessel, helicopters
Trading Bay area geohazard survey	Middle Cook Inlet	2020	April-October	30 days	1 vessel with echosounders and/or sub-bottom profilers
Trading Bay area exploratory wells	Middle Cook Inlet	2020	April-October	120-150 days	1 jack-up rig [1], drive pipe installation, vertical seismic profiling, tugs towing rig, support vessel, helicopters
Granite Point production drilling and geohazard survey	Middle Cook Inlet	2019	June-November	120-150 days	1 jack-up ri[1]g, tugs towing rig, 1 vessel with echosounders
Drift River terminal decommissioning	Lower Cook Inlet, west side	2020-2023	April-October	120 days	Vessels

[1] Hilcorp will use one jackup rig for the OCS leases/wells, however, Hilcorp may drill in the OCS and North Cook Inlet in the same year, which would require the use oftwo jackup rigs.

2.1.1.1 Activities within Lower Cook Inlet

The lower Cook Inlet region is comprised of both Bureau of Ocean Energy Management (BOEM) OCS and State of Alaska Department of Natural Resources (DNR) Division of Oil and Gas (DOG) leases. Over the last 40 years there have been OCS lease sales in the Cook Inlet Planning Area, but there were no active leases until 2017 when BOEM held Lease Sale 244 in June 2017, offering 224 OCS blocks for sale. A Final Environmental Impact Statement (EIS) was prepared by BOEM (BOEM 2016). Hilcorp acquired 14 lease blocks in Lease Sale 244 and intends to start exploration activities. Under the BOEM OCS 2017-2022 Leasing Plan, another Cook Inlet lease sale is anticipated in 2021[1].

The State of Alaska DNR DOG holds annual lease sales under AS 38.05.035(e) and AS 38.05.180. Under these statutes, land that is subject to a finding that the lease is in the best interest of the State of Alaska issued within the previous 10 years may be offered for oil and gas leasing. The current area-wide leasing best interest finding is for 2009 through 2018[2]. Hilcorp holds State leases throughout Cook Inlet.

The following text outlines the type of activities and anticipated dates and duration in the lower Cook Inlet region (Figure 2).

[1] https://www.boem.gov/2017-2022-Lease-Sale-Schedule/

[2] https://aws.state.ak.us/OnlinePublicNotices/Notices/Attachment.aspx?id=110219

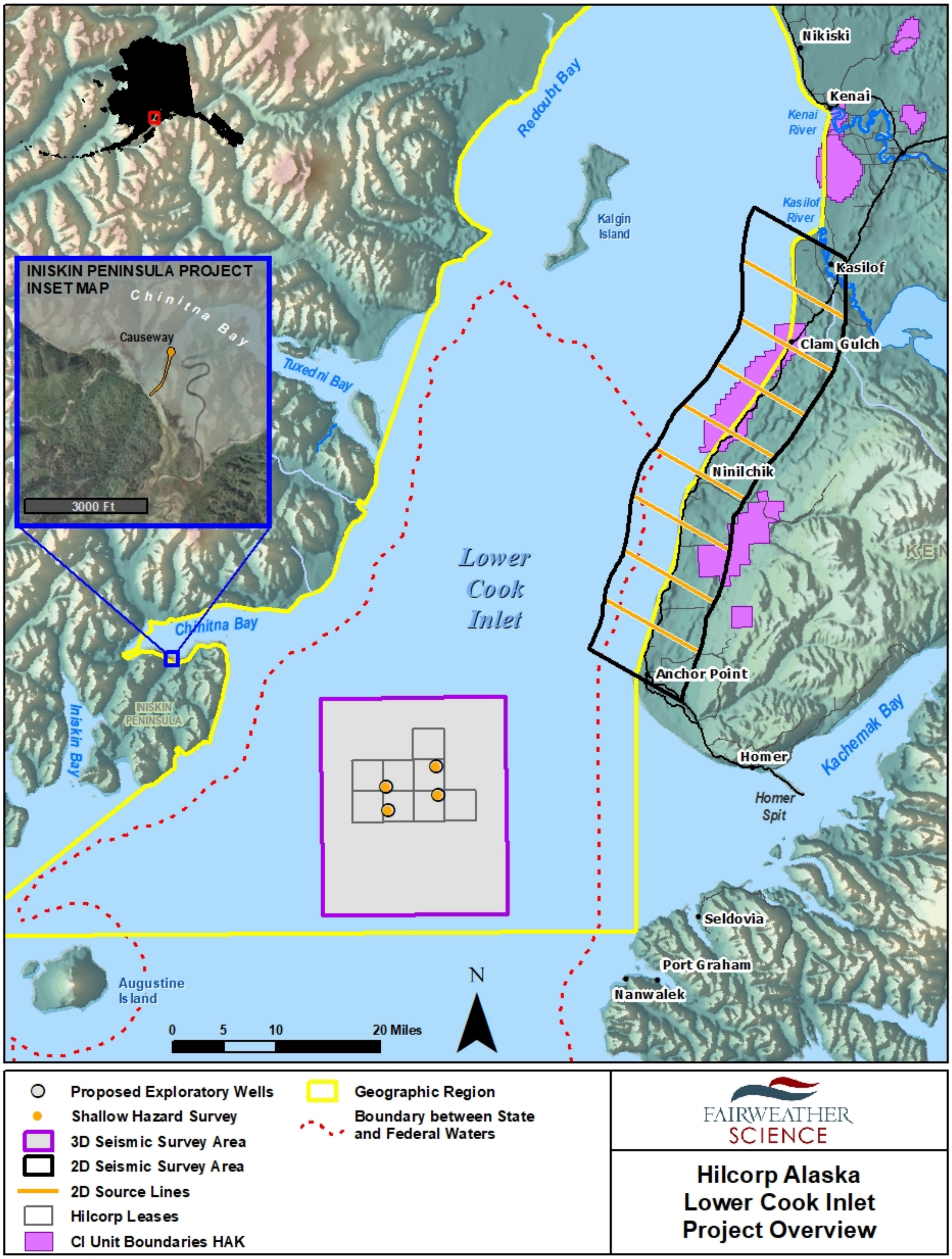

Figure 2. Map showing Hilcorp's planned activities in lower Cook Inlet.

2D Seismic Survey

Based on potential future lease sales in both State and Federal waters, operators collect two-dimensional (2D) seismic data to determine the location of possible oil and gas prospects. Generally, 2D survey lines are spaced farther apart than three-dimensional (3D) surveys and are conducted in a regional pattern that provides less detailed geological information. 2D surveys are used to cover wider areas to map geologic structures on a regional scale. Airgun arrays sizes used during 2D surveys are similar to those used during 3D surveys.

The region of interest to conduct a 2D survey is in the marine, intertidal, and onshore area on the eastern side of Cook Inlet from Anchor Point to Kasilof (Figure 2). The area of interest is approximately 8 kilometers (km; 5 miles [mi]) on each side of the coastline (Figure 2). The anticipated timing of the planned 2D survey is in the open water season (April through October) in either 2021 or 2022. The total survey duration (with onshore and nearshore work) will take approximately 30 days in either year. In-water seismic activities are expected to take approximately 10 days.

<u>2D Seismic Design</u>

The methods for acquiring 2D seismic data in this zone are anticipated to be similar to what was performed by Apache Alaska Corporation (Apache) in 2011 and 2012; however, specific details of the program have not yet been developed. Similar to this program, the anticipated Hilcorp work will include land, intertidal, and marine environments. However, the Apache nearshore survey was 3D and this planned nearshore survey is 2D. This opinion does not evaluate acoustic harassment associated with the land-based portion of the program because it is not anticipated to result in underwater sound levels exceeding NMFS acoustic harassment thresholds.

The 2D seismic data are acquired using airguns in the marine zone, airguns in the intertidal zone when the tide is high and drilled shot holes in the intertidal zone when the tide is low and drilled shot holes in the land zone. The data are recorded using an autonomous nodal system (i.e., no cables) that are deployed in the marine, intertidal, and land zones. The planned source lines (airgun and shot holes) are approximately 16 km (10 mi) in length running perpendicular to the coastline (Figure 2). The source lines are spaced every 8 km (5 mi) in between Anchor Point and Kasilof, with approximately 9 to 10 lines over the area of interest (Figure 2). Additional details on the sources and recorders are provided in the following text.

<u>Marine 2D Seismic Source</u>

In the marine and high tide intertidal zones, data will be acquired using a shallow water airgun towed behind one source vessel. Although the precise volume of the airgun array is unknown at this time, Hilcorp will use an airgun array similar to what has been used for surveys in Cook Inlet by Apache (2011 through 2013) and SAExploration (2015): either a 2,400 cubic inch (cui) or 1,760 cui array. In addition, the source vessel will be equipped with a 440 cui shallow water source which it can deploy at high tide in the intertidal area in less than 1.8 meter (m, 6 feet [ft]) of water. Source lines are oriented along the node line.

A single vessel is capable of acquiring a source line in approximately 1 to 2 hours (hrs) traveling at speeds between 3 and 4 knots (kn), depending on the tidal current. In general, only one source line will be collected in one day to allow for all the node deployments and retrievals, and intertidal and land zone shot holes drilling. There are up to 10 source lines, if all operations run smoothly, there will only be 2 hr per day over 10 days of airgun activity. Hilcorp anticipates the entire operation to take approximately 30 days to complete to account for weather and equipment contingencies.

Onshore/Intertidal 2D Seismic Source

In the land and low tide intertidal zones, data will be acquired using shot holes drilled every 50 m (165 ft) along the source lines (Figure 2). To access the onshore shot hole sites, Hilcorp may use a combination of helicopter portable and tracked vehicle drills. At each source location, Hilcorp will drill to the prescribed hole depth of approximately 10 m (35 ft) and load it with 4 kilograms (kg; 8.8 pounds [lbs]) of explosive. The hole will be capped with a "smart cap" that will make it impossible to detonate the explosive without the proper blaster.

Recording System

The recording system that will be employed is an autonomous system "nodal" (i.e., no cables), which is expected to be made up of at least two types of nodes; one for the land and one for the intertidal and marine environment (Figure 3). For the land environment, this will be a single-component sensor land node; for the intertidal and marine zone, this will be a submersible multi-component system made up of three velocity sensors and a hydrophone. These systems have the ability to record continuous data. Inline receiver intervals for the node systems are approximately 50 m (165 ft). For 2D seismic surveys, the nodes are deployed along the same line as the seismic source. The deployment length is restricted by battery duration and data storage capacity.

The marine nodes will be placed using one node vessel; the intertidal and land nodes will be placed by personnel using tracked vehicles.

Figure 3. Land-based nodal technology (left) and water-based nodal technology (right).

Sensor Positioning

In the marine environment, once the nodes are placed on the seafloor, the exact position of each node is required. There are several techniques used to locate the nodes on the seafloor, depending on the depth of the water. In very shallow water, the node positions are either surveyed by a land surveyor when the tide is low, or the position is accepted based on the position at which the navigator has laid the unit. In deeper water, a hull or pole mounted pinger will be used to send a signal to the transponder which is attached to each node. The transponders are coded and the crew knows which transponder goes with which node prior to the layout. The transponder's response (once pinged) is added together with several other responses to create a suite of range and bearing between the pinger boat and the node. Those data are then calculated to precisely position the node. In good conditions, the nodes can be interrogated as they are laid out. It is also common for the nodes to be pinged after they have been laid out.

Onshore and intertidal locating of source and receivers will be accomplished with Differential Global Positioning System/roving units (DGPS/RTK) equipped with telemetry radios which will be linked to a base station established on the source vessel. Survey crews will have both helicopter and light tracked vehicle support. Offshore source and receivers will be positioned with an integrated navigation system (INS) utilizing DGPS/RTK link to the land base stations. The integrated navigation system will be capable of many features that are critical to efficient safe operations. The system will include a hazard display system that can be loaded with known obstructions, or exclusion zones.

Vessels

The source and node vessels have not yet been confirmed but will be similar to those used by Apache and SAExploration in Cook Inlet for previous surveys. Details of each vessel are provided in Table 2.

Table 2. Description of vessels for 2D seismic survey.

Name	Primary Activity	Specifications
M/V *Peregrine Falcon* (or similar)	Source vessel	26 m length x 26 m breadth 197 gross tonnage 10 berths
M/V *Miss Diane I* (or similar)	Node vessel	26 m length x 26 m breadth 53 gross tonnage 6 berths

Fuel Storage

Any fuel storage will be located away from waterways and positioned within a secondary containment area (SCA). The capacity of the SCA will be 110 percent of the largest storage tank within the SCA. All storage fuel sites will be equipped with spill response equipment and supplies. Any transfer of fuel for offshore activities will comply with United States Coast Guard (USCG) regulations (33 CFR part 154).

3D Seismic Survey

Based on potential future lease sales in both State and Federal waters, operators collect 3D seismic data to determine the location of possible oil and gas prospects. Generally, 3D survey lines are spaced in a grid pattern concentrated on a specific area of interest. These surveys provide the resolution needed for detailed geological evaluation and data resolution for placement of drill rigs or platforms.

Hilcorp plans to collect 3D seismic data over 8 of the 14 OCS lease blocks in lower Cook Inlet (Figure 2). The 3D seismic survey is comprised of an area of 790 km^2 (305 miles [mi^2]), which includes a 3D survey area of 451 km^2 (174 mi^2) through 8 blocks (6357, 6405, 6406, 6407, 6455, 6456, 6457, 6458). Hilcorp submitted an application for an Incidental Harassment Authorization (IHA) in late 2017 for a planned survey in 2018, but withdrew the application and now plan for the survey to take place in 2019. Hilcorp plans to collect 3D seismic data for approximately 45-60 days in either the fall of 2019 (September-October) or spring of 2020 (April-May). Seismic surveys will not occur between November 1 and April 1 in compliance with identified BOEM lease stipulations (NMFS 2017b). The length of the survey will depend on weather, equipment, and marine mammal delays (contingencies of 20 percent weather, 12 percent equipment, 10 percent marine mammal).

3D Seismic Survey Design

Polarcus is the anticipated seismic contractor and the general seismic survey design is provided below. The 3D seismic data will be acquired using a specially designed marine seismic vessel towing 8-12 x ~2,400-m (1.5 mi) recording cables with a dual air gun array. The survey will involve one source vessel, one support vessel, one chase vessel, and potentially one mitigation vessel. The anticipated seismic source to be deployed from the source vessel is a 14-airgun array with a total volume of 1,945 cui. Crew changes are expected to occur every four to six weeks using a helicopter or support vessel from shore bases in lower Cook Inlet.

The proposed seismic survey will be active 24 hours (hrs) per day. The array will be towed at a speed of approximately 7.41 km/hr (4 knots), with seismic data collected continuously. Data acquisition will occur for approximately 3-5 hrs, followed by a 1.5-hr period to turn and reposition the vessel for another pass. The turn radius on the seismic vessel is approximately 3,200-4,828 m (2-3 mi), which includes a run-out area where guns are active, but outside the full-fold data acquisition area. The total area of airgun operations will be approximately 528 km^2 (204 mi^2).

The data will be shot parallel to the Cook Inlet shorelines in a north/south direction. This operational direction will keep recording equipment/streamers in line with Cook Inlet currents and tides and keep the equipment away from shallow waters on the east and west sides. The program may be modified if the survey cannot be conducted as a result of noise conditions onsite (i.e., ambient noise). The airguns will be turned off during the turns. The vessel will turn into the tides to ensure the recording cables/streamers remain in line behind the vessel. A diagram showing the relative positions of the source and streamer cables is provided in Figure 4.

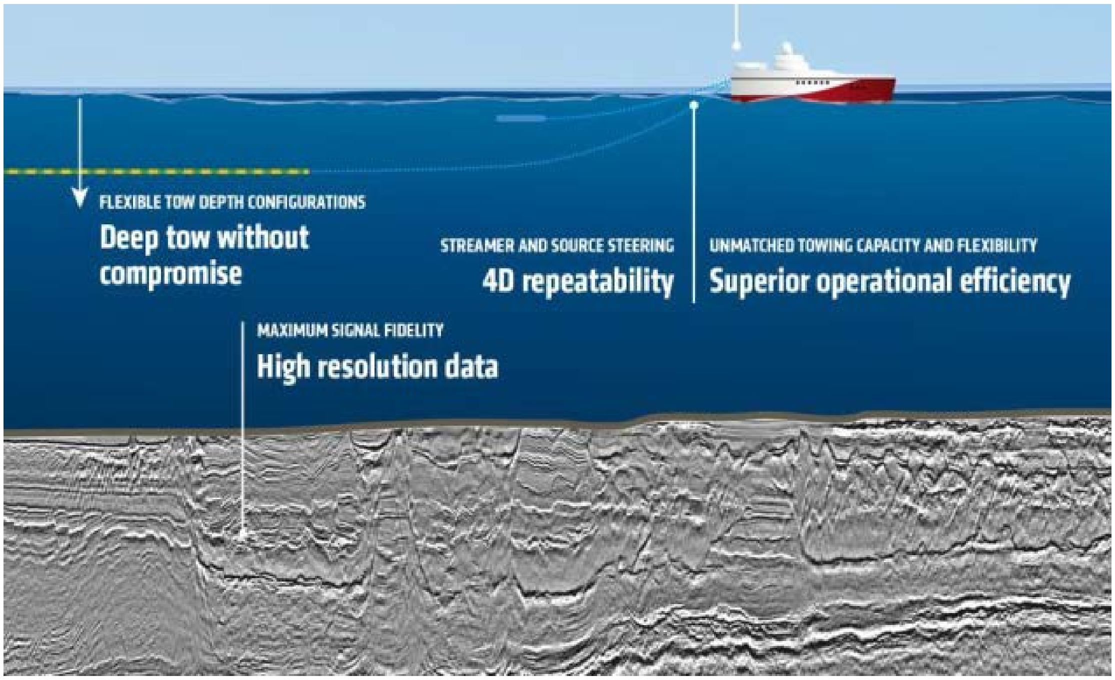

Figure 4. Diagram of typical seismic vessel with streamers and source.

Airguns

Hilcorp plans to use an array that provides for the lowest possible sound source to collect the target data. The proposed array is a Bolt 1900 LLXT dual gun array (Figure 5). The airguns will be configured as two linear arrays or "strings;" each string will have 7 airguns shooting in a "flip-flop" configuration for a total of 14 airguns. The airguns will range in volume from 45 to 290 cui for a total of 1,945 cui, as shown in the configuration provided in Figure 5. The first and last are spaced approximately 14 m (45.9 ft) apart and the strings are separated by approximately 10 m (32.8 ft). The two airgun strings will be distributed across an approximate area of 30 by 14 m (98.4 by 45.9 ft) behind the source vessel and will be towed 300 to 400 m (984 to1,312 ft) behind the vessel at a depth of 5 m (16.4 ft). The firing pressure of the array is 2,000 pounds per square inch (psi). The airgun will fire every 4.5 to 6 seconds (s), depending on the exact speed of the vessel. When fired, a brief (25 milliseconds [ms] to 140 ms) pulse of sound is emitted by all airguns nearly simultaneously.

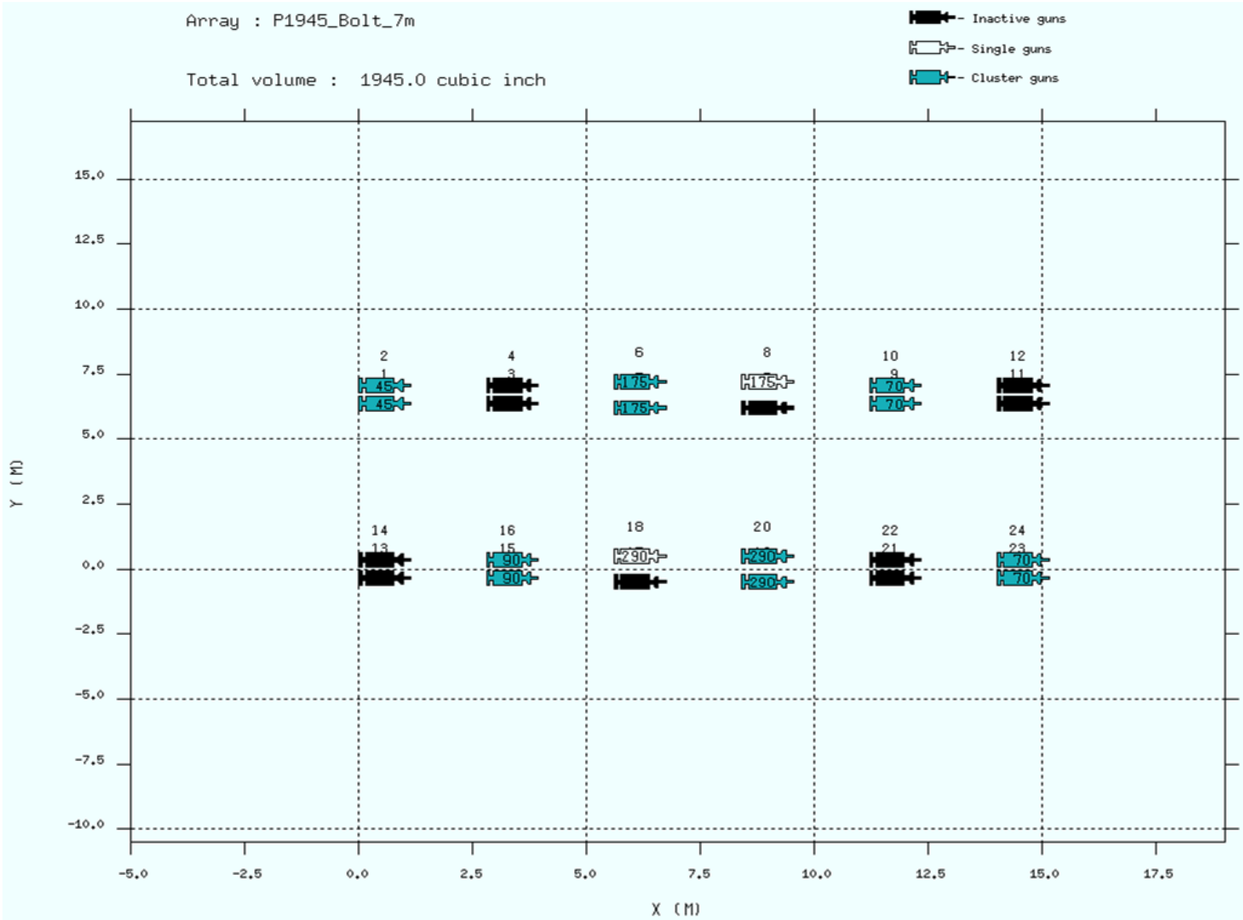

Figure 5. Layout of a 1,945 cui airgun array. Symbol size and labels indicate the volumes of the airgun in cubic inches. Tow direction is to the left.

Streamers

Hilcorp intends to use 8 Sercel-type solid streamers or functionally similar for recording the seismic data (Figure 4 and Figure 5). Each streamer will be approximately 2,400 m (1.5 mi) in length and will be towed approximately 8 to 15 m (26.2 to 49.2 ft) or deeper below the surface of the water. The streamers will be placed approximately 50 m (165 ft) apart to provide a total streamer spread of 350 to 550 m (1,148 to 1,804 ft). Solid streamers are now recognized as best in class for marine data acquisition because of unmatched reliability, signal to noise ratio, low frequency content, and noise immunity.

Vessels

The survey will involve one source vessel, one support vessel, one or two chase vessels, and one mitigation vessel. The source vessel tows the airgun array and the streamers. The support vessel provides general support for the source vessel, including supplies, crew changes, etc. The chase vessel monitors the in-water equipment and maintains a security perimeter around the streamers. The mitigation vessel provides a viewing platform to augment the marine mammal monitoring program. Details of anticipated vessels are provided in Table 3. Figure 6 shows a picture of a typical, modern source vessel. Figure 7 shows Polarcus environmental capabilities.

Table 3. Description of the vessels for the 3D seismic survey.

Name	Primary Activity	Specifications
M/V *Naila, Asima, Adira, or Alima* (or similar)	Source /Streamer vessel	92 m length x 21 m breadth 7.5 m draft 7,420 to 7,894 gross tonnage Built in 2010 Bahamas flag
M/V *Maria G* (or similar)	Support vessel Supports crew changes, supplies, etc.	53.8 m length x 13.8 m breadth 3.8 m draft 1,081 gross tonnage Built in 2009 Panama flag
TBD (1 or 2)	Chase vessel Maintains security around streamers	TBD

Figure 6. Photos of typical marine source/streamer vessels (left) and support vessels (right).

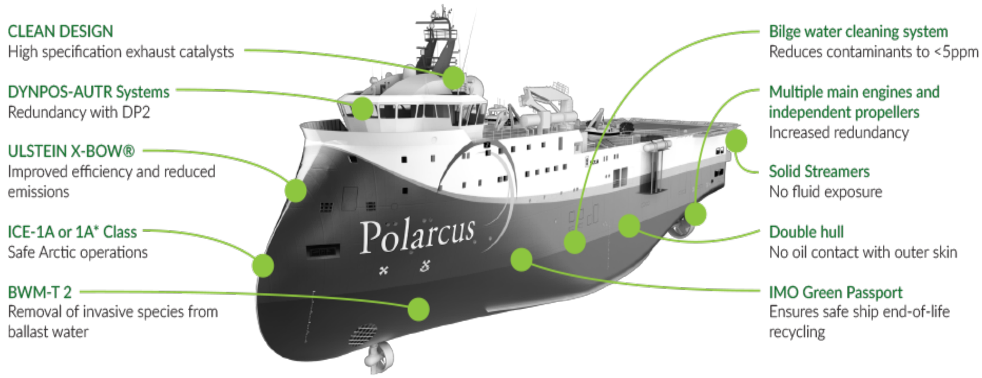

Figure 7. Polarcus source vessel's environmental capabilities.

Geohazard and Geotechnical Surveys

After completing a 3D seismic survey and prior to conducting exploratory drilling, operators perform a geohazard survey to evaluate any potential geological hazards; document any potential cultural resources or benthic communities to identify shallow hazards such as old pipelines or wrecks; obtain engineering data for placement of structures (e.g., proposed platform locations and pipeline routes); and detect subsurface geologic hazards (e.g., faults and gas pockets).

Upon completion of the 3D seismic survey over the lower Cook Inlet OCS leases, Hilcorp plans to conduct a geohazard survey on site-specific regions within the area of interest prior to conducting exploratory drilling. The precise location is not known, as it depends on the results of the 3D seismic survey, but the location will be within the lease blocks. The anticipated timing of the activity is in either the fall of 2019 or the spring of 2020. The actual survey duration will take approximately 30 days.

The suite of equipment used during a typical geohazards survey consists of single beam and multi-beam echosounders, which provide water depths and seafloor morphology; a side scan sonar that provides acoustic images of the seafloor; a sub-bottom profiler which provides 20 to 200 m (66 to 656 ft) sub-seafloor penetration with a 6- to 20-centimeter (cm, 2.4 to 7.9-inch [in]) resolution. Magnetometers, to detect ferrous items, may also be used. 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 or grab sampler.

The echosounders and sub-bottom profilers are generally hull-mounted or towed behind a single vessel. The ship travels at 3 to 4.5 knots (5.6 to 8.3 km/hr). Surveys are site specific and can cover less than one lease block in a day, but the survey extent is determined by the number of potential drill sites in an area. BOEM guidelines at NTL-A01 require data to be gathered on a 150 by 300 m (492 by 984 ft) grid within 600 m (1,969 ft) of the surface location of the drill site, a 300 by 600 m (984 by 1,969 ft) grid along the wellbore path out to 1,200 m (3,937 ft) beyond the surface projection of the conductor casing, and extending an additional 1,200 m beyond that limit with a 1,200 by 1,200 m grid out to 2,400 m (7,874 ft) from the well site.

Exploratory Drilling

Operators will drill exploratory wells based on mapping of subsurface structures using 2D and 3D seismic data and historical well information.

Hilcorp plans to conduct the exploratory drilling program April to October between 2020 and 2022. The exact start date is currently unknown and is dependent on the results of the seismic survey, geohazard survey, and scheduling availability of the drill rig. It is expected that each well will take approximately 40 to 60 days to drill and test. Beginning in spring 2020, Hilcorp plans to possibly drill two and as many as four exploratory wells, pending results of the 3D seismic survey in the lower Cook Inlet OCS leases. After testing, the wells may be plugged and abandoned (P&A).

Drill Rig

Hilcorp proposes to conduct its exploratory drilling using a rig similar to the *Spartan 151* drill rig. The *Spartan 151* is a 150 H class independent leg, cantilevered jack-up drill rig with a drilling depth capability of 7,620 m (25,000 ft) that can operate in maximum water depths up to 46 m (150 ft). To maintain safety and work efficiency, the *Spartan 151* or equivalent will be equipped with the following:

- Either a 5,000, 10,000, or 15,000 psi blowout preventer (BOP) stack, for drilling in higher pressure formations found at greater depths in Cook Inlet;
- Sufficient variable deck load to accommodate the increased drilling loads and tubular materials (i.e. drill pipe and drill bits) for deeper drilling;
- Reduced draft characteristics to enable the rig to easily access shallow water locations;
- Riser tensioning system to adequately deal with the extreme tides/currents in up to 46 m (150 ft) water depth;
- Steel hull designed to withstand -10 degrees Celsius (°C) to eliminate the risk of steel failure during operations in Cook Inlet (i.e., built for North Sea arctic conditions); and
- Ability to cantilever over existing platforms for working on development wells.

Rig Mobilization

Depending on the rig selection and location, the drilling rig will be towed on site using up to three ocean-going tugs licensed to operate in Cook Inlet. While under tow to the well sites, rig operations will be monitored by Hilcorp and the drilling contractor management. Very High Frequency (VHF) radio, satellite, and cellular phone communication systems will be used while the rig is under tow.

Oil Field Support Services

The rig will be stocked with most of the drilling supplies required to complete a full summer program. Deliveries of remaining items, including crew transfers, will be performed by support vessels and helicopters. The majority of the oilfield support services contractors have offices, shops, and additional equipment located in Anchorage, Kenai, and Nikiski that will support their remote field operations. The tugs used to mobilize the rig will be released once the rig is in place and workboat(s) staged at the Offshore Systems Kenai (OSK) Dock in Nikiski or at the Homer Dock in Homer for supporting operations.

Helicopter Operations

Helicopter logistics for project operations will include transportation for personnel, groceries, and supplies. Helicopter support will consist of a twin turbine Bell 212 (or similar) helicopter certified for instrument flight rules for land and over water operations. The helicopter will be based at the Kenai Airport, OSK Heliport, and/or Homer Airport to support rig crew changes and cargo handling. Fueling will take place at these facilities. No helicopter refueling will take place on the rig.

Helicopter flights to and from the rig are expected to average two per day. Flight routes will follow a direct route to and from the rig location, and flight heights will be maintained 300 to 450 m (1,000 to 1,500 ft), as practicable, above ground level (AGL) to avoid acoustical harassment of marine mammals. The aircraft will be dedicated to the drilling operation and will be available for service 24 hrs a day.

Supply Vessels Operations

Major supplies will be staged on-shore at the OSK Dock in Nikiski. Required supplies and equipment will be moved from the staging area by contracted supply vessels and loaded aboard the rig when the rig is established on a drilling location and will include fuel, drilling water, mud materials, drilling tools, cement, casing, and well service equipment. Supply vessels also will be outfitted with fire-fighting systems as part of fire prevention and control as required by Cook Inlet Spill Prevention and Response, Inc. (CISPRI). The specific supply vessels have not been identified; however, typical offshore drilling support work vessels are of steel construction with strengthened hulls to provide the capability of working in extreme conditions. Supply vessels are capable of moving personnel when severe weather won't allow helicopter flights.

Fuel

Rig equipment will use diesel fuel or electricity from generators. Personnel associated with fuel delivery, transfer, and handling will be knowledgeable of Industry Best Management Practices (BMP) related to fuel transfer and handing, drum labeling, secondary containment guidelines, and the use of liners/drip trays.

The jack-up rig will take on a maximum fuel load prior to operations to reduce fuel transfers during drilling. Commercial tank farms in the Nikiski or Kenai area will supply fuel transported by workboats as needed. The Rig Barge Master will be in charge of re-fueling and fluid transfers between the rig and fuel workboats, and subsequent transfers between tanks on the rig.

Drilling Program and Well Operations

The drilling program for the well will be described in detail in an Exploration Plan to BOEM. The Exploration Plan will present information on the drilling mud program; casing design, formation evaluation program; cementing programs; and other engineering information. After rig up/rig acceptance by Hilcorp, the wells will be spudded and drilled to bottom-hole depths of approximately 2,100 to 4,900 m (7,000 to 16,000 ft) depending on the well. It is expected that each well will take about 40 to 60 days to drill and up to 10 to 21 days of well testing. If two wells are drilled, it will take approximately 80 to 120 days to complete the full program; if four wells are drilled, it will take approximately 160 to 240 days to complete the full program.

Blowout Prevention Program and Equipment

All operating procedures on the rig, whether automated or controlled by company or contractor personnel, are specifically designed to prevent a loss of well control. The primary method of well control utilizes the hydrostatic pressure exerted by a column of drilling mud of sufficient density to prevent an undesired flow of formation fluid into the well bore. In the unlikely event that primary control is lost, surface BOP equipment would be used for secondary control. Hilcorp will use a 5,000, 10,000 or 15,000 psi BOP stack depending on the anticipated formation pressures to be encountered and offset well information.

Well Plugging and Abandonment (P&A)

When planned and permitted operations are completed, the well will be suspended according to Bureau of Safety and Environmental Enforcement (BSEE) regulations. The well casings will be landed in a mudline hanger after each hole section is drilled. When the well is abandoned, the production casing is sealed with mechanical plugging devices and cement to prevent the movement of any reservoir fluids between various strata. Each casing string will be cut off below the surface and sealed with a cement plug. A final shallow cement plug will be set to approximately 3.05 m (10 ft) below the mudline. At this point, the surface casing, conductor, and drive pipe will be cut off and the three cutoff casings and the mudline hanger pulled to the deck of the jack-up rig for final disposal. The P&A procedures are part of the Well Plan which is reviewed by BSEE prior to being issued an approved Permit to Drill.

Waste Management Program

All drilling waste, wastewater, recyclables, hazardous waste, and municipal solid waste will be stored, transported, and disposed of in accordance with local, state, and federal regulations.

Drilling Fuel and Cutting

Drilling wastes include drilling fluids, known as mud, and rock cuttings will be circulated from downhole to the jack-up mud pit system. Non-hydrocarbon based drilling wastes will be discharged to the Cook Inlet under an approved Alaska Pollution Discharge Elimination System (APDES) general permit or sent to an approved waste disposal facility. Hydrocarbon based drilling wastes will be delivered to an onshore permitted location for disposal. Hilcorp will follow BMP and all stipulations of the applicable permits for this activity. Fluids and cutting management does not produce any noise signature to the marine environment that is not already included in other activities discussed herein.

Drive Pipe and Conductor Installation

A drive pipe is a relatively short, large-diameter pipe driven into the sediment prior to the drilling of oil wells. The drive pipe serves to support the initial sedimentary part of the well, preventing the looser surface layer from collapsing and obstructing the wellbore. Drive pipes are installed using pile driving techniques. Hilcorp proposed to drive approximately 60 m of 76.2-cm pipe at each well site prior to drilling using a Delmar D62-22 impact hammer (or similar). This hammer has an impact weight of 6,200 kg (13,640 lbs). The drive pipe driving event is expected to last one to three days at each well site, although actual pounding of the pipe will only occur intermittently during this period. Conductors are slightly smaller diameter pipes than the drive pipes used to transport or "conduct" drill cuttings to the surface. For these wells, a 50.8-cm [20-in] conductor pipe may be drilled, not hammered, inside the drive pipe, dependent on the integrity of surface formations.

<u>Vertical Seismic Profiling</u>

Once the well is drilled, accurate follow-up seismic data may be collected by placing a receiver at known depths in the borehole and shooting a seismic airgun at the surface near the borehole, called vertical seismic profiling (VSP). These data provide high-resolution images of the geological layers penetrated by the borehole and can be used to accurately correlate original surface seismic data. The actual size of the airgun array is not determined until the final well depth is known, but typical airgun array volumes are between 600 and 880 cui. VSP typically takes less than two full days at each well site.

Iniskin Peninsula Exploration Project

Hilcorp initiated baseline exploratory data collection in 2013 for a proposed land-based oil and gas exploration and development project on the Iniskin Peninsula of Alaska, near Chinitna Bay (Figure 2). The proposed project is approximately 97 km (60 mi) west of Homer on the west side of Cook Inlet in the Fitz Creek drainage. New project infrastructure includes material sites, a 6.9 km (4.3 mi) long access road, prefabricated bridges to cross four streams, an air strip, barge landing/staging areas, fuel storage facilities, water wells and extraction sites, an intertidal causeway, a camp/staging area, and a drill pad. Construction is anticipated to start in 2020.

Initial delivery of construction equipment to the project location will be provided by low-draft tug and barge vessels. Barge landing/staging areas at Camp Point and Fitz Creek will be used for storage and stockpiling of supplies, equipment, and fuel during construction. To take advantage of favorable tides, some equipment and materials may be staged initially at the Camp Point staging area before being consolidated at the Fitz Creek staging area.

<u>Mooring Buoy</u>

A mooring buoy with two mooring lines may be installed in Chinitna Bay, approximately 0.9 km (0.5 nautical miles [nm]) north of Camp Point. Maximum swing radius of buoy, mooring line(s), and any attached barge(s) will not exceed 122 m (400 ft).

<u>Rock Causeway</u>

An intertidal rock causeway is proposed to be constructed adjacent to the Fitz Creek staging area to improve the accessibility of the barge landing during construction and drilling operations. The causeway will extend seaward from the high tide line approximately 366 m (1,200 ft) to a landing area 46 m (150 ft) wide. Rock fill will be sourced from the Gaikema material site. The rock will be laid out from the shoreline with land-based construction equipment, no in-water equipment will be needed. The causeway may be constructed in late 2019, but most likely will be in 2020 after all permits are received and equipment is contracted.

The causeway will enable more consistent use of the Fitz Creek staging area to receive freight and fuel with fewer limitations due to short high tide windows and result in less dependency on the Camp Point staging area. The causeway will also enable quicker response to emergency incidents (including spill events) and reduce the risk associated with materials logistics and fuel deliveries. After the causeway is no longer needed for the project, Hilcorp proposes that the rock fill be removed and relocated to a landowner-approved upland fill area, exposing the natural mud flat surface. Tidal action, wave action, and currents will be free to naturally fill and cover the area disturbed by project's causeway. The project camp site is located along the historic road alignment at a location where bedrock can be quarried and the pad developed by cutting to grade and utilizing excavated rock for fill. If removed, rock will be removed using land-based equipment and no vessels will be used.

Pile Driving

A dock face will be constructed around the rock causeway so that barges will be able to dock along the causeway. The causeway will need to be 75 percent built before the construction of the dock face will start. The dock face will be constructed with 18-m (60-ft) tall Z-sheet piles, all installed using a vibratory hammer. It will take approximately 14-25 days, depending on the length of the work shift, assuming approximately 25 percent of the day actual pile driving. The timing of pile driving will be in late summer or early winter, after the causeway has been partially constructed. The pile driving will also occur using land-based equipment on the newly constructed rock causeway, so no vessels will be used.

2.1.1.2 Activities within Existing Cook Inlet Assets

Hilcorp operates multiple assets throughout Cook Inlet in State of Alaska waters, including gathering facilities and platforms while Harvest operates the transmission pipelines, the Drift River Terminal, and the Christy Lee loading platform (Figure 1).

On the west side of Cook Inlet, Hilcorp operates the following onshore units: Ivan River, Lewis River, Pretty Creek, Stump Lake, and Beluga River. In the northern Kenai Peninsula, the company operates the Birch Hill Unit, the Swanson River Unit, the Beaver Creek Unit, the Sterling Unit, the Kenai Unit, and the Cannery Loop Unit. In the southern Kenai Peninsula, the company operates the Deep Creek Unit, the Ninilchik Unit, and the Nikolaevsk Unit. Operations within these units are onshore, so they do not have the potential to result in acoustic harassment of marine mammals in Cook Inlet and are, therefore, only provided as a reference for the scope of Hilcorp's operations.

Offshore, Hilcorp and Harvest operate the North Cook Inlet Unit, the Granite Point Unit, the Middle Ground Shoal Unit, the Trading Bay Unit, and the North Trading Bay Unit and associated McArthur River Field. The following text provides an overview of the existing Hilcorp and Harvest assets and planned activities within these areas (Figure 8).

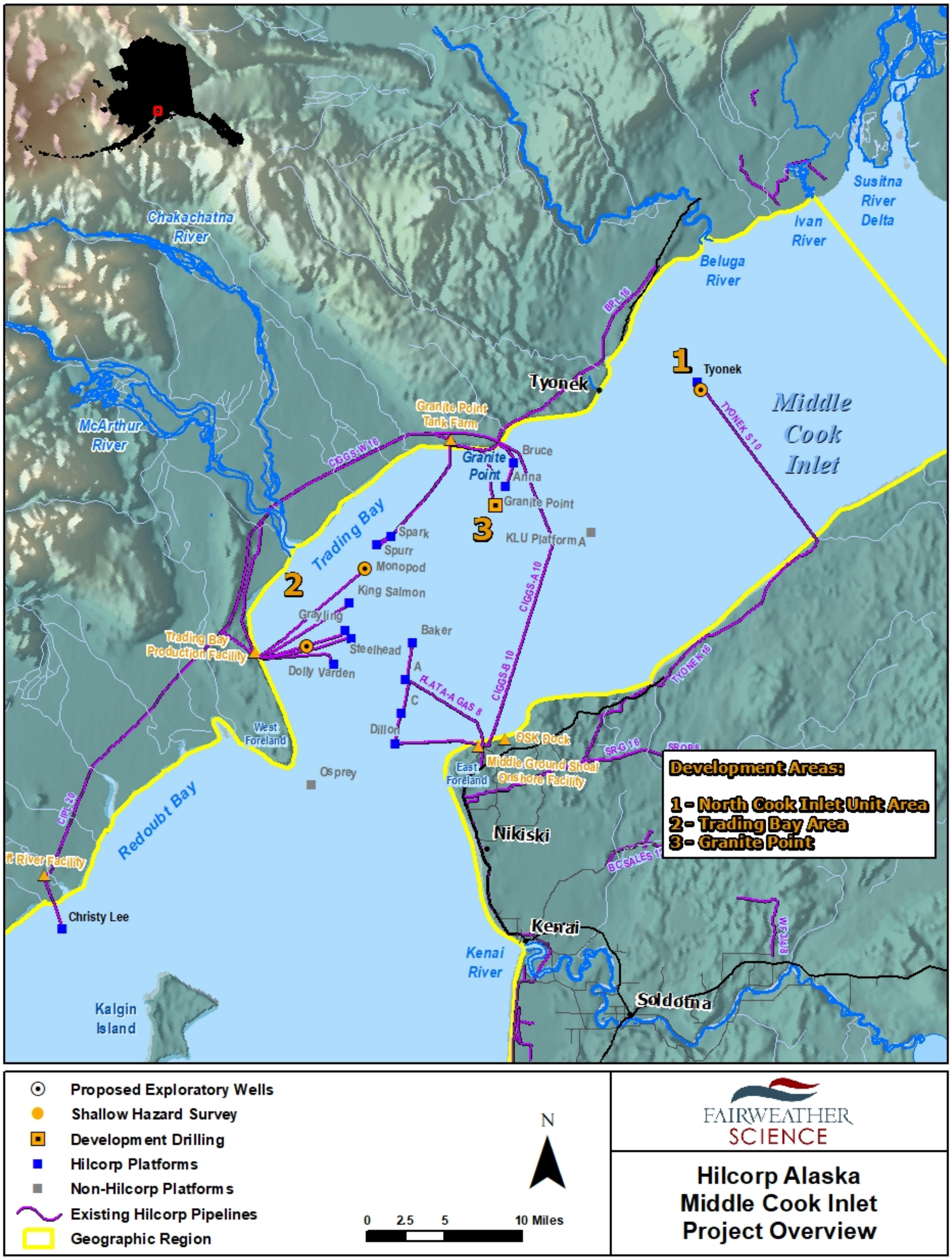

Figure 8. Map showing Hilcorp's existing and planned activities in middle Cook Inlet.

Offshore Production Platforms

Of the 17 production platforms in central Cook Inlet, 15 are owned by Hilcorp Alaska (Figure 8). The two remaining platforms are owned by Furie (KLU Platform A) and Glacier Oil and Gas (Osprey). Table 4 summarizes each of the Hilcorp Alaska-owned platforms.

Hilcorp Alaska performs routine construction on their platforms, depending on needs of the operations. Construction activities may take place up to 24 hrs a day. In-water activities would be limited to divers (outlined in the routine maintenance section below) and support vessels that will be bringing supplies five days a week up to two trips per day between OSK and the platform. Depending on the needs, there may also be barges towed by tugs with equipment and helicopters for crew and supply changes.

Table 4. Hilcorp Alaska production platforms in Cook Inlet.

Platform Name	Unit	Location (Lat/Lon)	Installation Date	Hilcorp Acquisition Date	Water Depth (at MLLW)	Number of Wells	Platform Status
A	Middle Ground Shoal	60.79521 151.49781	1964	2015	83 ft	15 producers, 1 disposal	Active
Anna	Granite Point	60.97638 151.31509	1966	2012	77 ft	56	Active
Baker	Middle Ground Shoal	60.82868 151.48584	1965	2012	102 ft	36	Lighthoused
Bruce	Granite Point	60.99845 151.30017	1966	2012	62 ft	32	Active
C	Middle Ground Shoal	60.76341 151.50429	1967	2015	73 ft	13 producers, 1 disposal	Active
Dillon	Middle Ground Shoal	60.73491 151.51502	1966	2012	92 ft	21	Lighthoused
Dolly Varden	Trading Bay	60.80712 151.63504	1967	2012	112 ft	70	Active
Granite Point	Granite Point	60.95758 151.33374	1966	2013	75 ft	40	Active
Grayling	Trading Bay	60.83919 151.61529	1967	2012	125 ft	61	Active
King Salmon	Trading Bay	60.86485 151.60804	1967	2012	73 ft	53	Active
Monopod	Trading Bay	60.89629 151.58100	1966	2012	66 ft	106	Active
Spark	North Trading Bay	60.92833 151.53055	1968	2013	62 ft	6	Lighthoused
Spurr	North Trading Bay	60.91944 151.55722	1968	2013	67 ft	6	Lighthoused
Steelhead	Trading Bay	60.83128 151.60423	1986	2012	183 ft	36	Active
Tyonek	North Cook Inlet	61.07583 150.950277	1968	2016	100 ft	19	Active

Offshore Production Drilling

Hilcorp Alaska routinely conducts development drilling activities at offshore platforms. Development drilling activities occur from existing platforms in Cook Inlet through either open well slots or existing wellbores in existing platform legs. All Hilcorp platforms have a potential for development drilling activities. Drilling activities from platforms within Cook Inlet are accomplished by using conventional drilling equipment from a variety of rig configurations.

Some other platforms in Cook inlet have permanent drilling rigs installed that operate under power provided by the platform power generation systems, while others do not have drill rigs, and the use of a mobile drill rig is required. Mobile offshore drill rigs may be powered by the platform power generation (if compatible with the platform power system) or self-generate power with the use of diesel fired generators.

Helicopter logistics for development drilling program operations will include transportation for personnel and supplies. The helicopter support will be managed through existing offshore services based at the OSK Heliport to support rig crew changes and cargo handling. Helicopter flights to and from the platform while drilling is occurring is anticipated to increase (on average) by two flights per day from normal platform operations.

Major supplies will be staged on-shore at the OSK Dock in Nikiski. Required supplies and equipment will be moved from the staging area to the platform in which drilling occurring by existing supply vessels that are currently in use supporting offshore operations within Cook Inlet. Vessel trips to and from the platform while drilling is occurring is anticipated to increase (on average) by two trips per day from normal platform operations. During mobile drill rig mobilization and demobilization, one support vessel is used continuously for approximately 30 days to facilitate moving rig equipment and materials.

<u>Granite Point Platform</u>

Hilcorp Alaska plans to conduct a multi-well development drilling program at the Granite Point Platform between June and November 2019. The exact start date is currently unknown and is dependent on scheduling availability of the drill rig and receipt of all applicable authorizations. A jack-up rig will be cantilevered over the Granite Point Platform and utilized to complete the drilling program with the same equipment and methods as described in the *Exploratory Drilling* section above (lower Cook Inlet OCS exploratory wells). All currently proposed wells are sidetracks and or completions of existing wellbores. It is expected that each well will take approximately 40 to 60 days to drill and test and convert to production if applicable. A geohazard survey over the areas of interest would be conducted to locate potential hazards prior to drilling with the same suite of equipment as described in the *Geohazard and Geotechnical Surveys* section above, with the exception of the use of a sub-bottom profiler. Because the wells are sidetracks, there is no need to survey beneath the seafloor so only echosounders and side scan sonar are used (all above 200 kHz).

Oil and Gas Pipelines

Natural gas is supplied to Southcentral Alaska via pipeline from the Kenai assets. Hilcorp Alaska has the ability to ship gas via either the west or east side of Cook Inlet up to Anchorage. Gas is transported across Cook Inlet via the CIGGS line and is boosted with a compressor station located at KPL Junction, which makes having the redundant system for gas supply possible. From the Tyonek platform, the Tyonek Pipeline goes directly to the KPL Junction and LNG plant area. When owned by ConocoPhillips, the Tyonek Pipeline was used to supply gas to the LNG plant that is now inactive. Harvest and Hilcorp currently tie the Tyonek Pipeline into the existing KBPL gas pipelines near the KPL junction.

The Cook Inlet Pipeline takes product from GPTF and TBPF to market via tanker from Drift River Terminal and the Christy Lee loading platform. The Drift River Terminal currently has two of its four possible 270,000-barrels of oil (bbl) tanks in service to store oil that accumulates from the platforms via the gathering facilities. There is a road on top for heavy equipment to access the tank farm.

Routine Maintenance

Each year, Hilcorp Alaska must verify the structural integrity of their platforms and pipelines located within Cook Inlet. Routine maintenance activities include: subsea pipeline inspections, stabilizations, and repairs; platform leg inspections and repairs; and anode sled installations and/or replacement. Hilcorp Alaska’s routine maintenance of platforms and pipelines requires the use of dive support vessels, hydraulic grinders, underwater pipe cutter, and drones for inspection and repair of these facilities. Through a five-year United States Army Corps of Engineers (USACE) Nationwide Permit 3, the Applicant received a Letter of Concurrence (LOC) from NMFS for the period of 2017 through 2024. To ensure these maintenance activities are covered through June 1, 2024, the activities are included in this opinion.

Table 5 provides the timing and durations of the proposed maintenance and repair activities. As this is a five-year plan, the exact dates each year are not known. In general, pipeline stabilization and pipeline repair are anticipated to occur in succession for a total of 6 to 10 weeks. However, if a pipeline stabilization location also requires repair, the divers will repair the pipeline at the same time they are stabilizing it. Pipeline repair activities are only to be conducted on an as-needed basis whereas pipeline stabilization activities will occur annually. During underwater inspections, if the divers identify an area of the pipeline that requires stabilization, they will place Sea-Crete bags at that time rather than waiting until the major pipeline stabilization effort that occurs later in the season.

Table 5. Timing and durations of Cook Inlet maintenance and repair activities.

Location	Activity	Estimated Timing	Estimated Duration	Frequency	Anticipated Resources						
					Dive Support	Multi-Beam Sonar	Water jet	Sea-Crete	Helicopter	RA Team	Drones
Subsea Pipelines	Pipeline Inspections	Apr/May	2 weeks	Annual	X	X	X	X			
	Pipeline Stabilization	Jun-Oct	3-5 weeks	Annual	X		X	X			
	Pipeline Repair	Jun-Oct	3-5 weeks	As needed	X		X	X			
Platform Legs	Platform Leg Inspection and Repair - *Subsea*	Apr-Jun	3 weeks	Annual	X		X	X			
	Platform Leg Inspection and Repair – *Tidal Zone*	May-Jul	3 weeks per wrap	As needed					X	X	X
Anode Sleds	Anode Sled Installation / Replacement	May-Aug	2-3 weeks	As needed	X		X	X			

[1] The legs of the platforms are wrapped with plates for ice and corrosion.

<u>Subsea Pipelines</u>

Natural gas and oil pipelines located on the seafloor of the Cook Inlet are inspected on an annual basis using ultrasonic testing (UT), cathodic protection surveys, multi-beam sonar surveys, and sub-bottom profilers. Deficiencies identified are corrected using pipeline stabilization methods or USDOT-approved pipeline repair techniques.

Pipeline Inspections

Hilcorp employs dive teams to conduct physical inspections and evaluate cathodic protection status and thickness of subsea pipelines on an annual basis. If required for accurate measurements, divers may use a water jet to provide visual access to the pipeline. For stabilization, inspection dive teams may place Sea-Crete bags beneath the pipeline to replace any materials removed by the water jet. Results of the inspections are recorded and significant deficiencies are noted for repair.

Multi-beam sonar and sub-bottom profilers may also be used to obtain images of the seabed along and immediately adjacent to all subsea pipelines. Strong currents within the Cook Inlet can scour and erode the seafloor beneath the pipelines, creating potentially significant integrity issues. Specifically, multi-beam sonar is used to evaluate and identify:

- Significant subsea topographic anomalies located within 10 ft of all pipelines
- Unsupported pipeline spans of 50 ft or greater
- Pipeline alignment

- Location of pipeline crossings
- Locations and tracking of the M/V *Monarch* shipwreck
- Up-to-date current velocity data

Elements of pipeline inspections that could produce underwater noise include:

- Dive Support Vessel (DSV)
- Water jet
- Multi-beam sonar/sub-bottom profiler and vessel

Pipeline Stabilization

Scour spans beneath pipelines greater than 23 m (75 ft) have the potential to cause pipeline failures. To be conservative, scour spans of 15 m (50 ft) or greater identified using multi-beam sonar surveys are investigated using dive teams. Divers perform tactile inspections to confirm spans greater than 15 m (50 ft). The pipeline is stabilized along these spans with Sea-Crete concrete bags.

While in the area, the divers will also inspect the external coating of the pipeline and take cathodic protection readings if corrosion wrap is found to be absent.

Elements of pipeline stabilization that could produce underwater noise include:

- DSV
- Water jet

Pipeline Repair

Significant pipeline deficiencies identified during pipeline inspections are repaired as soon as practicable using methods including, but not limited to, USDOT-approved clamps and/or fiber glass wraps, bolt/flange replacements, and manifold replacements. In some cases, a water jet may be required to remove sand and gravel from under or around the pipeline to allow access for assessment and repair. The pipeline surface may also require cleaning using a hydraulic grinder to ensure adequate repair. If pipeline replacement is required, an underwater pipe cutter such as a diamond wire saw or hydraulically-powered Guillotine saw may be used.

Elements of pipeline repair that could produce underwater noise include:

- DSV
- Water jet
- Hydraulic grinder
- Underwater pipe cutter

<u>Platform Legs</u>

Hilcorp Alaska's platforms in Cook Inlet are inspected on a routine basis. Divers and certified rope access (RA) technicians visually inspect subsea platform legs. These teams also identify and correct significant structural deficiencies.

Platform Leg Inspection and Repair – Subsea

Platform leg integrity and pipeline-to-platform connections beneath the water surface are evaluated by divers on a routine basis (Table 5). Platform legs, braces, and pipeline-to-platform connections are evaluated for cathodic protection status, structure thickness, excessive marine growth, damage, and scour. If required, divers may use a water jet to clean or provide access to the structure. Material removed from the seafloor may be replaced by Sea-Crete bags to stabilize the pipeline. Cathodic protection of the platform legs and associated pipelines are evaluated using a submersible Silver Chloride half-cell coupled to a digital multi-meter. Cathodic protection readings are taken continuously while the divers travel down legs, along members/pipelines, and at all inspected nodes. Measurements are collected while the cathodic protection system remains active.

RA teams may use magnetic particle inspection (MPI) to detect structure surface and near-surface flaws. If necessary, remedial grinding using a hydraulic under water grinder may be required to determine extent damage and/or to prevent further crack propagation. All inspection results are recorded and significant deficiencies are noted for repair.

Elements of subsea platform leg inspection and repair that could produce underwater noise include:

- DSV
- Hydraulic grinder
- Water jet

Platform Leg Inspection and Repair – Tidal Zone

Platform leg integrity along the tidal zone is inspected on a routine basis. Difficult-to-reach areas may be accessed using either commercially-piloted unmanned aerial systems (UAS) or certified RA teams.

Commercially-piloted UASs may be deployed from the top-side of the platform to obtain images of the legs. These images are then used to direct further inspections using RA Teams. Platform legs and braces are evaluated for cathodic protection status, structure thickness, excessive marine growth, and damage. All welds and corrosion leg wraps along the platform leg are inspected for damage or peeling. Significant structural deficiencies identified during inspections are repaired as soon as practicable using methods including, but not limited to, coarse metal repair such as welding seams or patches or replacing wraps.

Platform leg braces may be repaired as necessary to maintain the structural integrity of the platform. Loose bolts or evidence of cracking may be repaired by replacing bolts, installing new clamps, applying a composite material, or replacing the entire brace. In some situations, filling the brace with a composite material may be the most effective method of repair.

These visual inspections occur on an annual basis for each platform. Generally, the UAS is in the air for 15 to 20 minutes at a time due to battery capacity, which allows for two legs and part of the underside of the platform to be inspected. The total time to inspect a platform is approximately 1.5 hrs of flight time. The UAS is operated at a distance of up to 30.5 m (100 ft) from the platform at an altitude of 9 to 15 m (30 to 50 ft) above sea level. To reduce potential harassment of marine mammals, the area around the platform would be inspected prior to launch of the UAS to ensure there are no flights directly above marine mammals.

Elements of tidal zone work that could disturb marine mammals include:

- UAS

Anode Sleds

Galvanic and impressed current anode sleds are used to provide cathodic protection for the pipelines and platforms in Cook Inlet. Galvanic anode sleds do not require a power source and may be installed along the length of the pipelines on the seafloor. Impressed current anode sleds are located on the seafloor at each of the corners of each platform and are powered by rectifiers located on the platform.

Anodes are placed at the seafloor using dive vessels and hand tools. If necessary, a water jet may be used to provide access for proper installation. Anodes and/or cables may be stabilized using Sea-Crete bags.

Elements of anode sled inspection and repair that could produce underwater noise include:

- DSV
- Water jet

Vessel Traffic

Hilcorp Alaska's maintenance activities will require the use of dive vessels, typically ranging up to 70 ft in length by 24 ft in width by 7 ft draft capable of approximately 7 knots, traveling with the speed of the incoming/outgoing tide. On average, vessels may travel approximately 8 miles per day (mi/day), three times each day for a total of about 48 mi/day during normal operations.

Pingers

Several types of moorings are deployed in support of Hilcorp Alaska operations; all of which require an acoustic pinger for location or release. The pinger is deployed over the side a vessel and a short signal is emitted to the mooring device. The mooring device responds with a short signal to indicate that the device is working, to indicate range and bearing data, or to illicit a release of the unit from the anchor. These are used for very short periods of time when needed.

The types of moorings requiring the use of pingers anticipated to be used for this project include acoustic moorings during the 3D seismic survey (assumed 2-4 moorings), node placement for the 2D survey (used with each node deployment), and potential current profilers deployed each season (assumed 2-4 moorings). The total amount of time per mooring device is less than 10 minutes during deployment and retrieval. To avoid disturbance, the pinger would not be deployed if marine mammals have been observed within 500 m (1,640 ft) of the vessel.

North Cook Inlet Unit Subsea Well P&A Activity

The discovery well in the North Cook Inlet Unit was drilled over 50 years ago and is planned to be abandoned, so Hilcorp Alaska plans to conduct a geohazard survey to locate the well and conduct P&A activities for a previously drilled subsea exploration well in 2020 (Figure 8).

The geohazard survey location is approximately 402 to 804 m (¼ to ½ mi) south of the Tyonek platform and will take place over approximately fourteen days (including down days for weather, equipment, and marine mammal delays) with a grid spacing of approximately 250 m (820 ft). The suite of equipment used during a typical geohazards survey consists of single beam and multi-beam echosounders, which provide water depths and seafloor morphology; a side scan sonar that provides acoustic images of the seafloor; a sub-bottom profiler which provides 20 to 200 m (66 to 656 ft) sub-seafloor penetration with a 6- to 20-cm (2.4-7.9-in) resolution. The echosounders and sub-bottom profilers are generally hull-mounted or towed behind a single vessel. The vessel travels at 3 to 4.5 knots (5.6 to 8.3 km/hr).

Trading Bay Area Exploratory Drilling

Hilcorp plans to conduct exploratory drilling activities in the Trading Bay area. The specific sites of interest have not yet been identified, but the general area is shown in Figure 8. Hilcorp will conduct geohazard surveys over the areas of interest to locate potential hazards prior to drilling with the same suite of equipment as described above in the *Geohazard and Geotechnical Surveys* section. The survey is expected to take place over 30 days in 2020 from a single vessel.

The exploratory drilling and well completion activities will take place in site-specific areas based on the geohazard survey. Hilcorp plans to drill 1 to 2 exploratory wells in this area in the open water season of 2020 with the same equipment and methods as described above in the *Exploratory Drilling* section. The drilling program is anticipated to take between 120 to 150 days.

Drift River Terminal Decommissioning

If the pipeline from the Drift River Terminal to Christy Lee is abandoned during the period of the ITR, the Drift River Terminal will be abandoned in place (i.e., no in-water work other than vessels).

2.1.2 Mitigation Measures

Hilcorp Alaska and Harvest Alaska will implement all mitigation measures and protocols outlined below that were agreed on by Hilcorp Alaska, Harvest Alaska, and NMFS Alaska Region and NMFS Permits Division on May 30, 2019. Cook Inlet beluga whales, humpback whales, fin whales and Steller sea lions could be exposed to Level A and Level B sound source levels during the proposed project; therefore, the applicant will implement mitigation measures to minimize Level A and Level B takes of marine mammals.

The applicant will notify NMFS 48 hours prior to the start of each activity that may cause harassment of marine mammals. If there is a delay in activity, Hilcorp Alaska and Harvest Alaska will also notify NMFS as soon as practicable.

Protected Species Observer Protocols

1. PSOs will have the following knowledge, skills and abilities:
    a. be in good physical condition and be able to withstand harsh weather conditions for an extended period of time;
    b. must have vision correctable to 20-20;
    c. be able to conduct field observations and data collection according to assigned protocols;
    d. writing skills sufficient to prepare understandable reports of observations and technical skills to complete data entry forms accurately; and
    e. identifying marine mammals in Alaskan waters to species based upon appearance or behavior;
    f. ability to classify marine mammal behavior types into pre-established categories.
2. PSOs will have training, orientation or experience with project operations sufficient to accurately report on activities occurring during marine mammal sightings.
3. PSOs will complete project-specific training prior to deployment to the project site (taught by an experienced trainer following a course syllabus approved by NMFS). This course will include training in:
    a. field identification of marine mammals and marine mammal behavior;
    b. marine mammal ecology;
    c. all other required skills for successfully completing duties as a PSO;
    d. ESA and MMPA regulations;
    e. mitigation measures outlined in the Biological Opinion;
    f. PSO roles and responsibilities.
4. PSOs will be positioned such that the applicable EZ (Table 6) for each activity is visible. Ideally this vantage point is an elevated stable platform from which the PSO has an unobstructed 360° view of the water (e.g., the elevated bridge on the source vessel, situated on the helideck or other elevated promontory on the jack-up rig, in aircraft). The PSOs will scan systematically with the naked eye and with binoculars.
5. PSOs will have the ability to effectively communicate orally, by radio and in person, with project personnel to provide real-time information on marine mammals.
6. PSOs will have the ability and authority to order appropriate mitigation measures, including measures to avoid unauthorized takes of marine mammals. Appropriate actions to minimize project effects (e.g., take) include, but are not limited to airgun shutdowns, reducing tug power while moving equipment, delay of aircraft or watercraft arrival or departure if doing so does not compromise human safety, altering the speed or course of, tugs and other support vessels.

7. The PSOs will be issued equipment sufficient to carry out their duties. Equipment may include the following:
    a. Range finder;
    b. Annotated chart (noting the rig location) and compass;
    c. Inclinometer;
    d. Two-way radio communication, or equivalent, with onsite project manager;
    e. Appropriate personal protective equipment;
    f. Daily tide tables for the project area;
    g. Watch or chronometer;
    h. Binoculars (7x50 or higher magnification) with built-in rangefinder or reticles (rangefinder may be provided separately);
    i. Handheld global positioning system;
    j. A copy of this Biological Opinion and all appendices, printed on waterproof paper and bound;
    k. Observation Record forms printed on waterproof paper, or weatherproof electronic device allowing for required PSO data entry.
8. PSO will have no other primary duties beyond watching for, acting on, and reporting events related to marine mammals. For crew members, this mitigation measure only applies during the time the crew member must assume the duties of the PSO due to the absence of a qualified PSO.
9. PSO will work in shifts lasting no longer than four (4) hours with at least a one (1) hour break from marine mammal monitoring duties between shifts. PSOs will not perform duties as a PSO for more than 12 hours in a 24-hour period (to manage PSO fatigue). Note that during the 1-hour break for a PSO, a crew member can be assigned to be the observer as long as they do not have other duties at that time and they have received instructions and tools to allow them to make and record marine mammal observations.
10. Prior to commencing in-water work or at changes in watch, PSOs should establish contact with person in charge (PIC) and operators (i.e., seismic, pile driving, aircraft, vessels, etc.). The PSO will brief the PIC as to shutdown procedures if the listed species are observed likely to enter or are within the shutdown zone, and shall request that the PIC instruct the crew to notify the PSO when a listed species is observed. If the PIC goes "off shift" and delegates his duties, the designated PIC should contact the PSO on duty to advise of the updated point of contact
11. The PSOs will observe and collect data on marine mammals in and around the project area for 30 minutes before, during, and for 30 minutes after all of Hilcorp’s activities for which take has been requested.

Exclusion and Safety Zones

12. The **Exclusion Zone** (EZ) is defined as the area in which all operations are **shut down** in the event a marine mammal (except for belugas) enters or is about to enter this zone. Shutdown will occur whenever a beluga whale is observed at any distance within the Level B zone. The **Safety Zone** (SZ) is an area larger than the EZ that can be adequately monitored. The distances for the EZ and SZ for each of the project activities are summarized in Table 6. Take will be recorded when animal(s) are observed within the calculated Level A or Level B zone. Please see Section 6.2.1.2 for the definitions of Level A and B harassment and how these zones were calculated.

    Where requirements for immediate actions/responses are noted, the requirements do not apply if they would create an imminent and serious threat to a person, vessel or aircraft. In that event, actions/responses will be taken as soon as possible. If additional mitigation measures are required for specific activities, they are listed in subsections below.

Table 6. Exclusion and Safety Zones for Each Proposed Activity

Activity	**Exclusion Zone (m)** *If an activity has an EZ, shutdown will occur whenever a beluga whale is observed at any distance*	**Safety Zone (m)**
2D/3D Seismic	500	1,500[7]
Sub-bottom profiler	100	1,500[7]
Pipe driving	500	1,500[7]
Vertical Seismic Profiling (VSP)	500	1,500[7]
Vibratory sheet pile driving	100	1,500[7]
Water jet[8]	15	1000
Hydraulic grinder[8]	250	500
Pinger[1]	N/A	500
Drilling[2,8]	N/A	500
Well construction activities[2,8]	N/A	500
Tug towing rig[3,8]	N/A	1,500[7]

Dynamic Positioning (DP) thrusters[4,8]	N/A	1,500[7]
Aircraft in route[5]	N/A	500
Aircraft Take off / Landing from Rig[6,8]	N/A	500

Note: If the activity has an EZ, Hilcorp will shutdown the activity when a marine mammal(s) is expected to enter or is observed within the associated EZ zone.

[1]The 6 m zone radius shutdown zone is impractical to implement and monitor because most of the ensonified area is occupied by the vessel. However, the PSO will monitor a radius of 500 m prior to pinger deployment and ensure no marine mammals are within this area.

[2]A PSO will monitor waters within 500 m of drilling and well construction sites 30 minutes prior to startup of any activities that produce in-water sound to ensure marine mammals are not within the zone and exposed to an abrupt increase in sound level.

[3]Tug operations cannot discontinue controlling rig transport without causing risk to life, property, or the environment, but PSOs will continue to monitor for, and report on, the presence of marine mammals within 1,500 m of a tug; an animal is not considered taken if it approaches within 1,500 m of a tug.

[4]If the use of DP thrusters are anticipated, a PSO will monitor the 3,600 m zone for 30 minutes prior to the vessel engaging the DP thrusters to ensure no marine mammals are within or are likely to enter the zone. Prior to the arrival of a vessel that is likely to engage its DP thrusters, the PSO will monitor waters within 1,500 m of the vessel for 30 minutes and will ensure that the vessel arrival at the jack-up rig occurs when this zone is devoid of marine mammals (or at a portion of the tide cycle that will not require the use of DPS thrusters).

[5]All aircraft (excluding aircraft participating in pre-seismic aerial surveys), will transit at an altitude of 1,500 feet or higher, to the extent practical, while maintaining Federal Aviation Administration flight rules (e.g., avoidance of cloud ceiling, etc.), excluding take-offs and landings.

[6]A PSO on the jack-up rig will monitor a 500 m zone around the jack-up rig prior to landings and take-offs and will contact the helicopter pilot calling for a delay in approach and landing or take-off if any marine mammals are within or are likely to enter the 500 m-radius zone during aircraft operations.

[7]The Level B zone is larger than the SZ.

[8]Either a PSO, diver, or crewmember can monitor the SZ.

13. Hilcorp must not engage in noise-producing activities that are likely to exceed the 120 dB threshold within 10 miles (16 km) of the mean higher high water (MHHW) line of the Susitna Delta (Beluga River to the Little Susitna River) between April 15 and October.

The purpose of this mitigation measure is to protect beluga whales in the designated critical habitat in this area that is important for beluga whale feeding and calving during the spring and fall months. The range of the setback required by NMFS was designated to protect this important habitat area and also to create an effective buffer where sound does not encroach on this habitat. This seasonal exclusion is proposed to be in effect from April 15-October 15. Activities can occur within this area from October 16-April 14.

14. If a marine mammal(s) is likely to enter the EZ, Hilcorp will shut down activities prior to the animal entering the EZ.
15. Shutdown will be initiated at the PSO's direction when warranted due to the presence of marine mammals.
16. Following a shutdown **of less than 30-minutes** for the following: 2D/3D seismic, subbottom profiling, pipe driving, VSP, vibratory sheet pile driving, water jetting, hydraulic grinding,(Table 6), the activity may be reinitiated only after the marine mammal(s) has been observed exiting the EZ. The animal(s) will be considered to have cleared the zone if it:
    a) Is visually observed to have left the EZ; or
    b) Has not been seen within the EZ for 15 min in the case of pinnipeds; or
    c) Has not been seen within the EZ for 30 min in the case of cetaceans.
17. Following a shutdown **of more than a 30-minute period**, for the following: 2D/3D seismic subbottom profiling, pipe driving, VSP, vibratory sheet pile driving, water jetting, hydraulic grinding, the PSOs will scan waters within the EZ (Table 6) and confirm no marine mammals are observed present within the EZ for a period of 30 minutes. If one or more marine mammals are observed within or appear likely to enter the EZ, activity will not begin until marine mammals exit the EZ of their own accord **and** the EZ has remained clear of marine mammals for 30 minutes immediately prior to in-water activity. Take will be record when animal(s) are observed within the Level A or Level B zone.
18. Prior to commencing, 2D/3D seismic operations, DP thrusters, drilling, well construction activities, aircraft takeoff and landing from rig, and pinger operation, and when these activities have ceased, the PSOs will scan waters within the SZ (Table 6) and confirm no marine mammals are observed within the SZ for a period of 30 minutes. If one or more marine mammals are observed within or are likely to enter the SZ, activity will not begin until marine mammals exit the SZ of their own accord **and** the SZ has remained clear of marine mammals for 30 minutes immediately prior to the in-water activity.
19. Monitoring of the SZ and EZ will continue for 30 minutes following the completion of the 2D/3D seismic, sub-bottom profiler, pipe driving, VSP, and sheet pile driving operations.

2D and 3D Seismic Activity

Please refer to the *Exclusion and Safety Zone* section above for the required shutdown zones and measures.

20. No 2D seismic airgun activity before June within the level B radius (which maybe updated based on the SSV) of the Kasilof River.

21. During 2D/3D seismic activity, Hilcorp will conduct daily aerial overflights to ensure that the SZ for the intended area of seismic activity for that day contains no beluga whales. If weather conditions prohibit aerial surveys, seismic operations may begin prior to completing the daily aerial survey, however, aerial surveys must be conducted as soon as weather permits. This measure would only apply to 2D and 3D seismic surveying, not to other sound sources related to geohazard survey or well construction.
22. For 2D seismic surveys, airgun operations will be conducted during daylight hours.
23. For 3D seismic surveys, airgun operations may be conducted at night if ramp up procedures are conducted at the beginning of each new line and airguns are shutdown between shooting of lines.
24. A "ramp up" procedure gradually increases airgun volume at a specified rate.
    a) Ramp up is used at the start of airgun operations, including after a shutdown, and after any period greater than 10 minutes in duration without airgun operations.
    b) The rate of ramp up will be no more than 6 dB per 5-minute period.
    c) Ramp up will begin with the smallest gun in the array that is being used for all airgun array configurations.
    d) During the ramp up, the EZ for the full airgun array will be maintained.
    e) During daylight hours, if the complete EZ has not been visible for at least 30 minutes prior to the start of operations, ramp up will not commence. This means that it will not be permissible to ramp up an airgun array from a complete shut down in fog or at other times when the outer part of the EZ is not visible.
    f) Ramp up of the airguns will not be initiated, or will discontinue, if a marine mammal is sighted within or entering the EZ.
25. Hilcorp will be required to shut down all airguns between shooting of lines (no airgun operations during turns between lines).
26. The shutdown procedure must be accomplished within the period of time it typically takes for two "shots" of the airgun array to occur. If a marine mammal appears likely to enter the EZ, the vessel's speed and/or direct course maybe changed as a possible alternative to shutting down. If the mammal appears likely to enter the EZ, further mitigation actions must be taken, i.e., either further course alterations, or shutdown of the airguns.
27. Hilcorp will account for takes that have occurred during seismic exploration outside of the safety zone and monitoring zone:

    Safety zone – 1,500 m from seismic vessel

    Monitoring zone – any area monitored by PSOs (at least 8 percent of level B zone in good visibility conditions)

    Level B zone – area of the level B acoustic harassment zone. In order to ensure a conservative approach in accounting for instances of acoustic harassment for each species of marine mammal during seismic surveys, Hilcorp must:

a. Monitor the entire safety zone and record the number of animals observed in that zone, and
b. Monitor all or a portion of the level B zone to the edge of the level B zone using a method that is approved by NMFS AKR and NMFS Permits Division, and use this methodology to estimate take that has occurred; and
c. Ensure that the estimates from a and b above do not provide take estimates that are less than the number of animals observed within any portion of the level B zone. This will be accomplished by implementing the following take accounting rules:
    i. The total number of animals taken will be the sum of animals taken within the Safety Zone plus the spatial (#2) and temporal (#3) extrapolation of the number of animals observed within the remaining monitored zone.
    ii. Animals that are initially observed outside of the monitored zones but that cross into the monitored zone will be counted as animals observed within the monitored zone, and expansion of their numbers as described above will be applied.

Sub-bottom Profiler

Please refer to the *Exclusion and Safety Zones* section above for the required EZ, SZ, and applicable measures. Additional mitigation measures that apply to sub-bottom profilers are below.

28. Sub-bottom profiler operations will generally be conducted during daylight hours but may continue beyond nautical dusk provided the sub-bottom profiler was in operation continuously since nautical dusk. Sub-bottom profiler operations may not begin under low visibility conditions in which the SZ cannot be observed in its entirety.
29. A shutdown is defined as suspending all sub-bottom profiler activities. The shutdown procedure must be accomplished within 2 minutes of the determination that a marine mammal is within or appears likely to enter the EZ.

Pipe Driving and Vibratory Sheet Pile Driving

Please refer to the *Exclusion and Safety Zones* section above for the required EZ, SZ, and applicable measures. Additional mitigation measures that apply to pipe driving and vibratory sheet pile driving installation and removal are below.

30. For pipe driving and sheet pile driving installation and removal, operations will be conducted during daylight hours.
31. Two PSOs will be stationed aboard the rig during pipe driving and either on a vessel or on land during vibratory pile driving installation and removal.
32. Once the EZ has been cleared of all marine mammals, soft-start procedures will be implemented immediately prior to impact pipe driving activities. Soft-start is comprised of an initial set of three strikes from the hammer at about 40 percent energy, followed by a 30-second waiting period, then two subsequent three-strike sets with associated 30-second waiting periods at the reduced energy.

33. Initial hammering will not begin when the entire SZ is not visible, including during periods of poor visibility (e.g., night, fog, wind).
34. If visibility degrades to where the PSO determines that he/she cannot ensure whether a marine mammal enters the EZ during pipe or pile driving, the applicant may continue to drive the section of pipe or pile that was being driven to its target depth when visibility degraded to unobservable conditions, but will not drive additional sections of pipe or pile. If pipe or pile driving is suspended (to weld on a new section, for example) when the EZ is not visible in its entirety, the applicant will not resume pipe or pile driving until visibility is determined to be adequate by the PSO and the PSO has indicated that the zone has remained devoid of marine mammals for 30 minutes prior to additional pipe or pile driving.
35. During sheet pile removal, minimizing the release of materials contained by the sheet piles into marine waters will occur. Effort will be made to remove as much material impounded by the sheet piles as practicable; however, some spill of materials into marine water is expected during removal of the sheet piles. After the sheet pile is removed pre- and post-construction surveys will occur along the location of the face sheets to determine the scope of the removal effort.

Vertical Seismic Profiling

Please refer to the *Exclusion and Safety Zones* section above for the required EZ, SZ, and applicable measures. Additional mitigation measures that apply to VSP are below.

36. VSP operations will be conducted during daylight hours.
37. PSOs will monitor the EZ and SZ throughout VSP activities (Table 6).

Water Jet and Hydraulic Grinder

Please refer to the *Exclusion and Safety Zones* section above for the required EZ, SZ, and applicable measures. Additional mitigation measures that apply to water jets and hydraulic grinders are below.

38. Water jet and hydraulic grinder activities will not start during nighttime, but may continue if already started.
39. PSO(s) will monitor the EZ and SZ throughout water jet and hydraulic grinder activities (Table 6).
40. Divers will be immediately notified via radio to cease activity if a listed species is observed within or entering the EZ.

Fill Placement

41. Fill material will consist of rock fill that is free of fine sediments to the extent practical, to reduce suspended materials from entering the water column during tidal cycles. Fill material will also be free of invasive marine and terrestrial vegetation species.

Construction and Heavy Machinery

Please refer to the *Exclusion and Safety Zones* section above for the required EZ, SZ, and applicable measures. Additional mitigation measures that apply to construction and heavy machinery are below.

42. Unless otherwise indicated above, a minimum 10 m shutdown zone will be observed for in-water construction and heavy machinery not addressed elsewhere in these measures.

Vessel

Please refer to the *Exclusion and Safety Zones* section above for the required EZ, SZ, and applicable measures. Additional mitigation measures that apply to project vessels are below.

43. Vessel operators will maintain a vigilant watch for marine mammals to avoid vessel strikes.
44. Consistent with NMFS marine mammal viewing guidelines (https://alaskafisheries.noaa.gov/pr/mm-viewing-guide), operators of vessels will, at all times, avoid approaching within 100 yards of marine mammals. Operators will observe direction of travel of marine mammals and attempt to maintain a distance of 100 yards or greater between the animal and the vessel by working to alter vessel course or velocity.
45. The vessel operator will avoid placing the vessel between members of a group of marine mammals in a way that may cause separation of individuals in the group from other individuals in that group. A group is defined as being three or more whales observed within a 500-m (1641-ft) area and displaying behaviors of directed or coordinated activity (e.g., group feeding).
46. If the vessel approaches within 1.6 km (1 mi) of observed whales, except in emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the whales by taking one or more of the following actions, as appropriate:
    a. Steering to the rear of the direction of travel of the whale(s) to avoid causing changes in their direction of travel.
    b. Maintaining vessel speed of 10 knots or less when transiting to minimize the likelihood of lethal vessel strikes.
    c. Reducing vessel speed to less than 5 knots (9 km/hour) within 274 m (300 yards or 900 ft) of the whale(s).
47. Vessels should take reasonable steps to alert other vessels in the vicinity of whale(s).
48. Vessels will not allow tow lines (other than seismic arrays) to remain in the water, and no trash or other debris will be thrown overboard, thereby reducing the potential for marine mammal entanglement.
49. The applicant will implement measures to minimize risk of spilling hazardous substances.

50. The vessel operator will not purposely approach within 3 nautical miles (nm; 5.5 km) of major Steller sea lion rookeries or haulouts where vessel safety requirements allow and/or where practicable. Vessels will remain 3 nm (5.5 km) from all Steller sea lion rookery sites listed in paragraph 50 CFR 224.103 (d)(1)(iii).
51. Project vessel(s) operating in Cook Inlet will maintain a distance of 1.5 miles from the mean lower low water (MLLW) line of the Susitna Delta (MLLW line between the Little Susitna River and Beluga River (Figure 9).

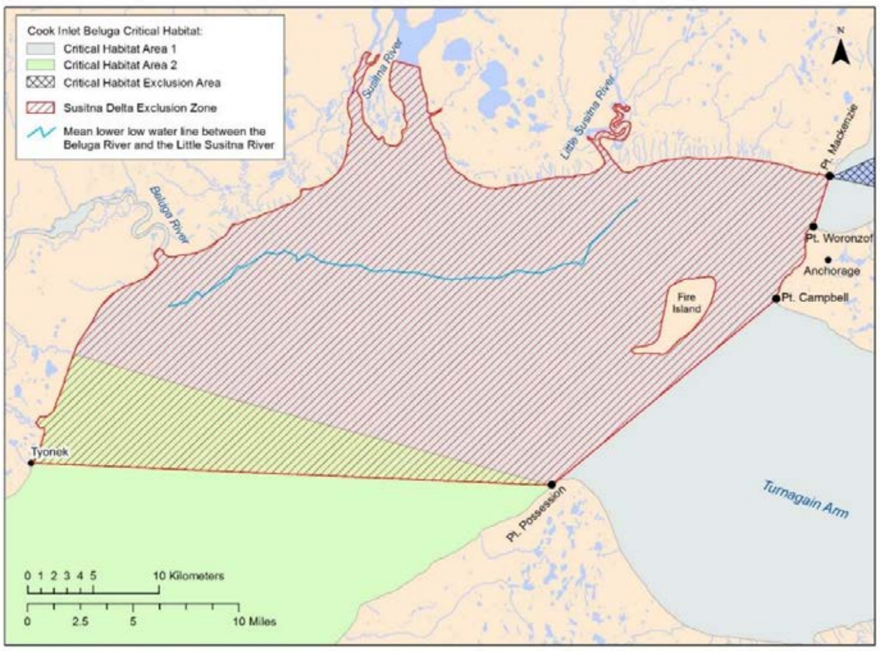

Figure 9. Susitna Delta Exclusion Zone, showing MLLW line between the Beluga and Little Susitna Rivers

Tug Towing Rig

52. PSOs aboard the tugs will monitor the SZ around each vessel while it is under power. Any sightings of marine mammals and avoidance measures will be documented by the PSOs on a sighting form, or the information will be relayed to the rig-based PSO for documentation.

Dynamic Positioning

53. Within the operational needs of the project, the tug Captains will time their operations such that conditions will allow for a safe delivery without the need for use of dynamic positioning. However, dynamic positioning may be used during emergency conditions to safeguard human life, avoid property damage, or reduce/avoid environmental damage.

54. If dynamic positioning is necessary during a slack tide[3], the on-duty PSOs will monitor the SZ around the rig for 30 minutes prior to slack tide and throughout slack tide to ensure the area is devoid of marine mammals. Monitoring during slack tide periods may discontinue when the vessel Captain has indicated that tidal currents are sufficient to make use of dynamic positioning unnecessary.
55. Rig personnel and the tug Captains will be made aware of project mitigation measures, and will plan the timing of operations to minimize the need for bow thruster use to the extent practicable.
56. PSOs will be on-site to monitor the SZ during dynamic positioning if the Captain of the vessel indicates the use of bow thrusters may be necessary.
57. If marine mammals are observed within the SZ (when bow thrusters may be necessary), the PSO will inform the vessel captain of the marine mammal's location, and the operations will be postponed. If dynamic positioning is already in progress during a delivery of supplies, the crew will be instructed to complete any lifts or transfers that are currently underway, and suspend additional lift/transfer activities until the marine mammal is no longer within the zone or has not been observed within the zone for 15 minutes (for pinnipeds) or 30 minutes (for cetaceans).

Aircraft

Please refer to the *Exclusion and Safety Zone* section above for the required EZ, SZ, and applicable measures. Additional mitigation measures that apply to aircraft are below.

58. During pre-seismic surveys (to clear the SZ, see Item 21), survey aircraft will fly at 1000 ft altitude, to the extent practicable, while maintaining Federal Aviation Administration flight rules (e.g., avoidance of cloud ceiling, etc.), excluding takeoffs and landing. This altitude maximizes the probability of seeing beluga whales in order to clear the Level B zone.
59. All aircraft (other than pre-seismic surveys, see Item 21) will transit at an altitude of 1,500 feet or higher, to the extent practical, while maintaining Federal Aviation Administration flight rules (e.g., avoidance of cloud ceiling, etc.), excluding takeoffs and landing. If flights must occur at altitudes less than 1,500 feet due to environmental conditions, aircraft will make course adjustments, as needed, to maintain at least a 1,500-foot separation from all observed marine mammals. Helicopters will not hover or circle above marine mammals.
60. The PSO on the jack-up rig will monitor a 500 m zone around the helideck prior to landings and take-off, will radio the helicopter pilot and call for a delay if any marine mammals are within the zone or are likely to enter the zone during aircraft operation.
61. Aircraft will keep a distance of at least 1 mi from Steller sea lion rookeries and haulouts.

[3] Slack tide is defined as one hour before until one hour after local high tide and one hour before until one hour after local low tide.

Other Mitigation Measures

62. All vessel and rig personnel will be responsible for cutting all unused packing straps, plastic rings, and other synthetic loops that have the potential to become entangled around fish or wildlife.
63. Hilcorp will supervise all drilling waste, solid waste, and wastewater leaving the platform and will be responsible for proper manifesting for transport and offsite disposal of these materials. All contractors working on the project will use waste minimization and recycling practices whenever practical. Solid waste will be classified, segregated, and labeled as: 1) general refuse, 2) hazardous, 3) Resource Conservation and Recovery Act (RCRA) exempt, or 4) RCRA nonexempt. Waste will be stored in designated satellite, recycling, and universal waste accumulation areas or appropriately labeled containers. The Health, Safety, and Environment representative will oversee waste management activities and will manifest wastes for transport and offsite disposal.
64. Increased vessel activity in the action area during project activities has the potential to temporarily increase the risk of accidental fuel and lubricant spills from support vessels. Impacts will be minimized by implementing the appropriate spill response plan and maintaining safe operational and navigational conditions.

Data Collection

Sound Source Verification

65. Hilcorp Alaska will conduct underwater acoustic monitoring for the purposes of conducting sound source verification (SSV). Acoustic monitoring will be conducted to document ambient noise conditions and to characterize the long-range propagation of sounds produced during the 3D seismic activity and sub-bottom profiler. These data will be used to help verify distances from the noise sources at which marine mammal impact thresholds may be reached. Data will be used to compare the estimated distances to ambient sound levels and impact thresholds used to verify the Level A and B zones. Hilcorp Alaska will provide draft and final SSV reports as soon as they are available.

PSO Data Collection

66. PSO will record observations on data forms or into electronic data sheets, electronic copies of which will be submitted to NMFS in a digital spreadsheet format in the annual and final reports (Items 74 and 75).
67. PSO will use a NMFS-approved Observation Record. Observation Records will be used to record the following:
    a. Date and time that activity and observation efforts begin and end;
    b. Weather parameters (e.g., percent cloud cover, percent glare, visibility) and sea state where the Beaufort Wind Force Scale will be used to determine sea-state (https://www.weather.gov/mfl/beaufort);
    c. Species, numbers, and, if possible, sex and age class of observed marine

mammals, along with the date, time, and location of the observation;

d. The predominant sound-producing activities occurring during each marine mammal sighting;

e. Marine mammal behavior patterns observed, including bearing and direction of travel;

f. Behavioral reactions of marine mammals just prior to, or during sound producing activities;

g. Location of marine mammals, distance from observer to the marine mammal, and distance from the predominant sound-producing activity or activities to marine mammals;

h. Whether the presence of marine mammals necessitated the implementation of mitigation measures to avoid acoustic impact, and the duration of time that normal exploration operations were affected by the presence of marine mammals.

Reporting Requirements

68. All reports submitted to NMFS Permits Division will be submitted to NMFS AKR.
69. **Exceedance of Authorized Take -** Hilcorp will immediately notify NMFS Permits Division and AKR (see Table 7 for contact information) if 30 or more belugas are detected within the Level B zone in an authorization year (June through May). If the number of authorized takes for any marine mammal species is met or exceeded, NMFS OPR will immediately reinitiate formal section 7 consultation on this action.
70. **Unauthorized Take -** In the unanticipated event that the specified activity causes the take of a marine mammal in a manner not authorized by the LOA and this opinion's ITS, such as an injury or mortality to a marine mammal, the observer will report the incident to Hilcorp, who will report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS and NMFS AKR (see Table 7 for contact information). Hilcorp must report any unanticipated or unauthorized take observed by its personnel or contractors, and this communication will occur as soon as practicable and within 24 hours of the occurrence. Following such an event, formal consultation will be reinitiated. A report documenting marine mammal takes will be submitted in a digital format that can be queried, and will include:
    a) Information that must be included in the PSO data collection (Item 67)
    b) Date, time, location (latitude/longitude) of incident;
    c) Species identification (if known) or description of the animal(s) involved (estimate on size and length);
    d) Number of animals affected;
    e) Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the incident;
    f) Cause of the event (e.g., vessel strike);
    Vessel's speed during and leading up to the incident;
    g) Vessel's course/heading and what operations were being conducted (if

applicable);

h) Status of all sound sources in use;
i) The time the animal(s) first observed and last seen, if known;
j) Description of avoidance measures/requirements that were in place at the time of the incident (ie, vessel strike, or entering the shutdown zone) and what additional measures were taken, if any;
k) Description of the behavior of the marine mammal immediately preceding and following the incident;
l) If available, description of the presence and behavior of any other marine mammals immediately preceding the incident;
m) Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and
n) To the extent practicable, photographs or video footage of the animal(s).

71. **Vessel Strike -** Though take of marine mammals by vessel strike is not authorized, if a listed marine mammal is struck by a vessel, it must be reported to NMFS (see Table 7 for contact information) within 24 hrs. The following will be included when reporting vessel collisions with marine mammals:
    a. Information that would otherwise be listed in the PSO data collection (Item 67).
    b. Number and species of marine mammals involved in collision.
    c. The date, time, and location of the collision.
    d. The cause of the take (e.g., vessel strike).
    e. The time the animal(s) was first observed and last seen.
    f. Mitigation measures implemented prior to and after the animal was taken.
    g. Contact information for PSO on duty at the time of the collision, ship's Pilot at the time of the collision, or ship's Captain.
72. **Marine Mammal Stranding** - If PSOs observe an injured, sick, or dead marine mammal (i.e., stranded marine mammal), they will notify the NMFS Alaska Region Marine Mammal Stranding Network at 1-877-925-7773. The PSOs will submit photos and data that will aid NMFS in determining how to respond to the stranded animal. Data submitted to NMFS in response to stranded marine mammals will include the following information:
    a) Date, time, location (latitude/longitude) of first discovery (and updated location information if known and applicable);
    b) Species or description and number of stranded marine mammals,
    c) Description of the stranded marine mammal's condition (including carcass condition if animal is dead):
    d) Event type (e.g., entanglement, dead, floating);
    e) Behavior of live-stranded marine mammals;
    f) If available, photographs or video footage of the animal(s); and
    g) General circumstances under which the animal(s) were discovered.

Monthly Report

73. Monthly reports will be submitted via email to NMFS AKR for all months with project activities by the 15th of the month following the monthly reporting period. For example, for the monthly reporting period of June 1-30, the monthly report must be submitted by

July 15th (see Table 7 for contact information). The monthly report will contain and summarize the following information:

a) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all project activities and marine mammal sightings.
b) Species, number, location, distance from the vessel, and behavior of any sighted marine mammals, as well as associated project activity (e.g., number of power-downs and shutdowns), observed throughout all monitoring activities.
c) An estimate of the number (by species) exposed to noise (based on visual observation) at received levels greater than or equal to the NMFS thresholds discussed above with a discussion of any specific behaviors those individuals exhibited.
d) A description of the implementation and effectiveness of the: (i) terms and conditions of the Biological Opinion's Incidental Take Statement (ITS); and (ii) mitigation measures of the LOA. For the Biological Opinion, the report must confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness for minimizing the adverse effects of the action on ESA-listed marine mammals.

Annual Report

74. Within 90 calendar days of the cessation of in-water work each year, a comprehensive annual report will be submitted to NMFS AKR for review. The report will synthesize all sighting data and effort during each activity for each year. NMFS will provide comments within 30 days after receiving annual reports, and Hilcorp must address the comments and submit revisions within 30 days after receiving NMFS comments. If no comments are received from the NMFS within 30 days, the annual report is considered completed. The report will include the following information:
    a) Summaries of monitoring effort including total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals.
    b) Analyses of the effects of various factors that may have influenced detectability of marine mammals (e.g., sea state, number of observers, fog/glare, and other factors as determined by the PSOs).
    c) Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover.
    d) Marine mammal observation data (i.e., PSO data as specified in Item 67) with a digital record of observation data provided in spreadsheet format
    e) Summary of implemented mitigation measures (i.e., shutdowns and delays)
    f) Number of marine mammals during periods with and without project activities (and other variables that could affect detectability), such as: (i) initial sighting distances versus project activity at the time of sighting; (ii) closest point of approach versus project activity; (iii) observed behaviors and types of movements versus project activity; (iv) numbers of sightings/individuals seen versus project

activity; (v) distribution around the source vessels versus project activity; and (vi) numbers of animals detected in the EZ/SZ.

g) Analyses of the effects of project activities on listed marine mammals

Final Report

75. In addition to providing NMFS monthly and annual reporting of marine mammal observations and other parameters described above, Hilcorp will provide NMFS AKR, within 90 days of project completion at the end of the five-year period, a report of all parameters listed in the weekly, monthly, and annual report requirements above, noting also all operational shutdowns or delays necessitated due to the proximity of marine mammals. NMFS AKR will provide comments within 30 days after receiving this report, and Hilcorp must address the comments and submit revisions within 30 days after receiving NMFS comments. If no comments are received from the NMFS within 30 days, the final report is considered as final.

Summary of Agency Contact Information

Table 7 Summary of agency contact information

Reason for Contact	**Contact Information**
Alaska Regional Office (AKR) - ESA Consultation Questions, Reports & Data Submittal	Greg Balogh: greg.balogh@noaa.gov, 907-271-3023 Bonnie Easley-Appleyard: bonnie.easley-appleyard@noaa.gov; 907-271-5172
Office of Protected Resources (OPR) – ITR/MMPA Questions, Report & Data Submittal	Jolie Harrison (Jolie.Harrison@noaa.gov) Sara Young (Sara.Young@noaa.gov)
Stranded, Injured, or Dead Marine Mammal *(not related to project activities)*	Stranding Hotline (24/7 coverage) 877-925-7773
Note: In the event that this contact information becomes obsolete please call NMFS Anchorage Main Office 907-271-5006	

2.2 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 consists of Hilcorp and Harvest's exploration, development, production and decommissioning activities in lower and middle Cook Inlet including the following:

Lower Cook Inlet

1. 2D seismic activity from Anchor Point to Kasilof River;
2. 3D seismic activity, geohazard surveys, and exploratory wells activity in 8 OCS blocks;
3. Exploration and development on the Iniskin Peninsula;
4. Vessel and aircraft transport from Nikiski, Kenai and Homer to locations within the project area; and
5. Waters and shorelines of Cook Inlet and the Shelikof Strait based on the Oil-Spill Risk Analysis (OSRA) conducted for the BOEM Lease Sale 244 (NMFS 2017b).

Middle Cook Inlet

1. Platform and pipeline maintenance;
2. North Cook Inlet Unit subsea geohazard surveys and well abandonment activities;
3. Trading Bay geohazard survey and exploratory well activity;
4. Granite Point Platform well development drilling activities;
5. Drift River terminal decommissioning; and
6. Vessel and aircraft transport from Nikiski, Kenai and Homer to locations within the project area.

The southern boundary of the action area extends southeast to the Kennedy Entrance of Cook Inlet and south into Shelikof Strait past Karluk, Alaska (Figure 10). This boundary is based on the OSRA conducted for the BOEM Lease Sale 244 and is adopted from the Biological Opinion for Lease Sale 244. 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 OCS block 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 for BOEM Lease Sale 244 (BOEM 2016), and below in Section 6 “Introduction of Pollutants into Waters”.

We define the northern boundary of the action area for this consultation to include the area within which project-related noise levels exceed ≥120 dB re 1 μPa (rms), and are expected to approach ambient noise levels (i.e., the point where no measureable effect from the project would occur). Within the northern portion of the action area, the loudest sound is emitted during geohazard and geotechnical surveys in the Northern Cook Inlet Unit Area (Figure 8) using a sub-bottom profiler. The proposed sub-bottom profiler operations at a source level of 210 dB re 1 µPa rms at 1 m. Applying the conventional practical spreading equation (with a transmission loss coefficient of 15) yields a 120 dB level B acoustic harassment threshold distance that extends into the upper reaches of Cook Inlet (Figure 10).

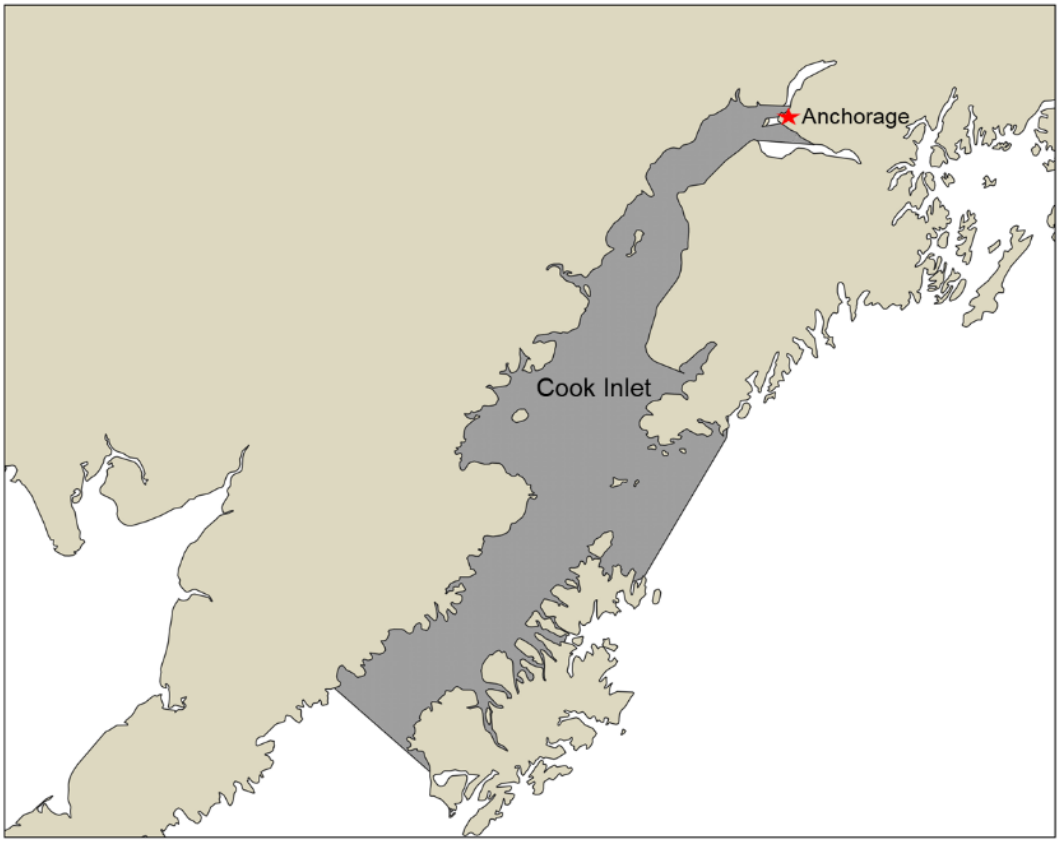

Figure 10. Action area (gray shaded area) for Hilcorp and Harvest oil and gas activities in Cook Inlet, Alaska.

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 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 2, 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).

While the ESA does not define “harass,” NMFS issued guidance interpreting the term “harass” under the ESA as a means 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).

The designation(s) of critical habitat for Cook Inlet beluga whales and Steller sea lions use(s) the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (81 FR 7414; February 11, 2016) replaced 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 PCE or essential feature, as appropriate for the specific critical habitat.

We used the following approach to determine whether the proposed action described in Section 2.1 of this opinion 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*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to stressors and the populations or subpopulations those individuals represent. 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 with the exposure analysis described in Section 6.2 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 6.3 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) reduce 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 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. The reasonable and prudent alternative must not be likely to jeopardize the continued existence of ESA-listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements

4 RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

Five populations of marine mammals listed under the ESA under NMFS's jurisdiction may occur in the action area. The action area also includes critical habitat for the Cook Inlet beluga whale and Steller sea lion. This opinion considers the effects of the proposed action on these species and designated critical habitats (Table 8).

Table 8. 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	NMFS 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 (*Eumetopias jubatus*)	Endangered	NMFS 1997, 62 FR 24345	NMFS 1993, 58 FR 45269

4.1 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 the definition of jeopardy under 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

This section consists of narratives for each of the endangered and threatened species 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.

More detailed background information on the status of these species can be found in a number of published documents including stock assessment reports on Alaska marine mammals (Muto et al. 2018) and recovery plans for fin whales (NMFS 2010c), humpback whales (NMFS 1991), Steller sea lions (NMFS 2008c), and Cook Inlet beluga whales (NMFS 2016a). Richardson et al. (1995) and Tyack (2000, 2008) provided detailed analyses of the functional aspects of cetacean communication and their responses to active seismic sources. Finally, Croll et al. (1999) and (NRC 2000, 2003, 2005) provide information on the potential and probable effects of active seismic sources on the marine animals considered in this opinion.

4.1.1 Cook Inlet Beluga Whales

4.1.1.1 <u>Status and Population Structure</u>

Beluga whales inhabiting Cook Inlet are one of five distinct stocks found in Alaska (Muto et al. 2018). The best historical abundance estimate of the Cook Inlet beluga population was from a survey in 1979, which estimated a total population of 1,293 belugas (Calkins 1989). NMFS began conducting comprehensive, systematic aerial surveys of the Cook Inlet beluga population in 1993. These surveys documented a decline in abundance from 653 belugas in 1994 to 347 belugas in 1998 (Figure 11). In response to this nearly 50 percent decline, NMFS designated the Cook Inlet beluga population as depleted under the Marine Mammal Protection Act in 2000 (65 FR 34590). The lack of population growth since that time led NMFS to list the Cook Inlet beluga as endangered under the ESA on October 22, 2008 (73 FR 62919). The most recent population estimate of 328 Cook Inlet beluga whales, derived from 2016 aerial surveys, indicates that the population's downward trend is continuing (Shelden et al. 2017).

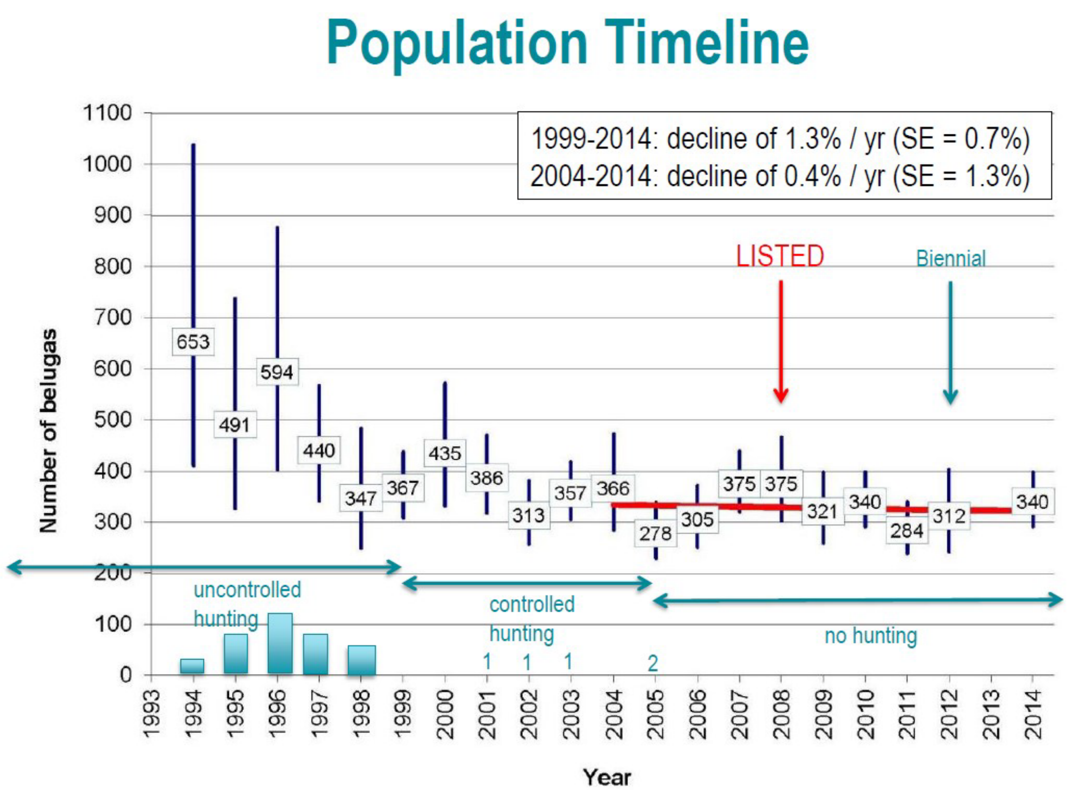

Figure 11. Population of Cook Inlet belugas. Blue bars and numbers along the x axis note known harvests of belugas during each year. Harvest methods used during the 1990s also resulted in many struck and lost belugas (NMFS 2017).

A detailed description of the Cook Inlet beluga whales' biology, habitat and extinction risk factors may be found in the endangered listing 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 2016a). 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.

4.1.1.2 Distribution and Occurrence in the Action Area

Cook Inlet beluga whales are geographically and genetically isolated from other beluga whale stocks in Alaska (Muto et al. 2018). Their distribution (Figure 12) overlaps almost in its entirety with the action area (Figure 10). Although they remain year-round in Cook Inlet, they demonstrate seasonal movements within the inlet. During the summer and fall, beluga whales generally occur in shallow coastal waters and are concentrated near the Susitna River mouth, Knik Arm, Turnagain Arm, and Chickaloon Bay (Nemeth et al. 2007). During the winter, they are more dispersed 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.

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. 2010)(Figure 12). Shelden et al. (2015b) report that the species' range in Cook Inlet has contracted markedly since the 1990s (Figure 12). Almost the entire population is now found only in northern Cook Inlet from late spring into the fall. In contrast, surveys in the 1970s showed whales dispersing into the lower inlet by mid-summer. Some 83 percent of the total population now occupies the Susitna Delta in early June, compared to roughly 50 percent in the past. A recent analysis of year-round data from passive-acoustic monitors corroborates results of previous aerial surveys and telemetry data, indicating that Cook Inlet belugas tend to congregate around the mouths of the Little Susitna, Beluga, Chickaloon, and Eagle Rivers during the summer months (Castellote et al. 2016).

This distributional shift and contraction coincided with the decline in abundance (Moore et al. 2000, NMFS 2008a, Goetz et al. 2012). Groups of over 200 individuals, including adults, juveniles, and neonates, have been observed in the Susitna Delta area (including the Beluga and Little Susitna Rivers) (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. Knik Arm and Turnagain Arm are also high use areas during the summer. 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).

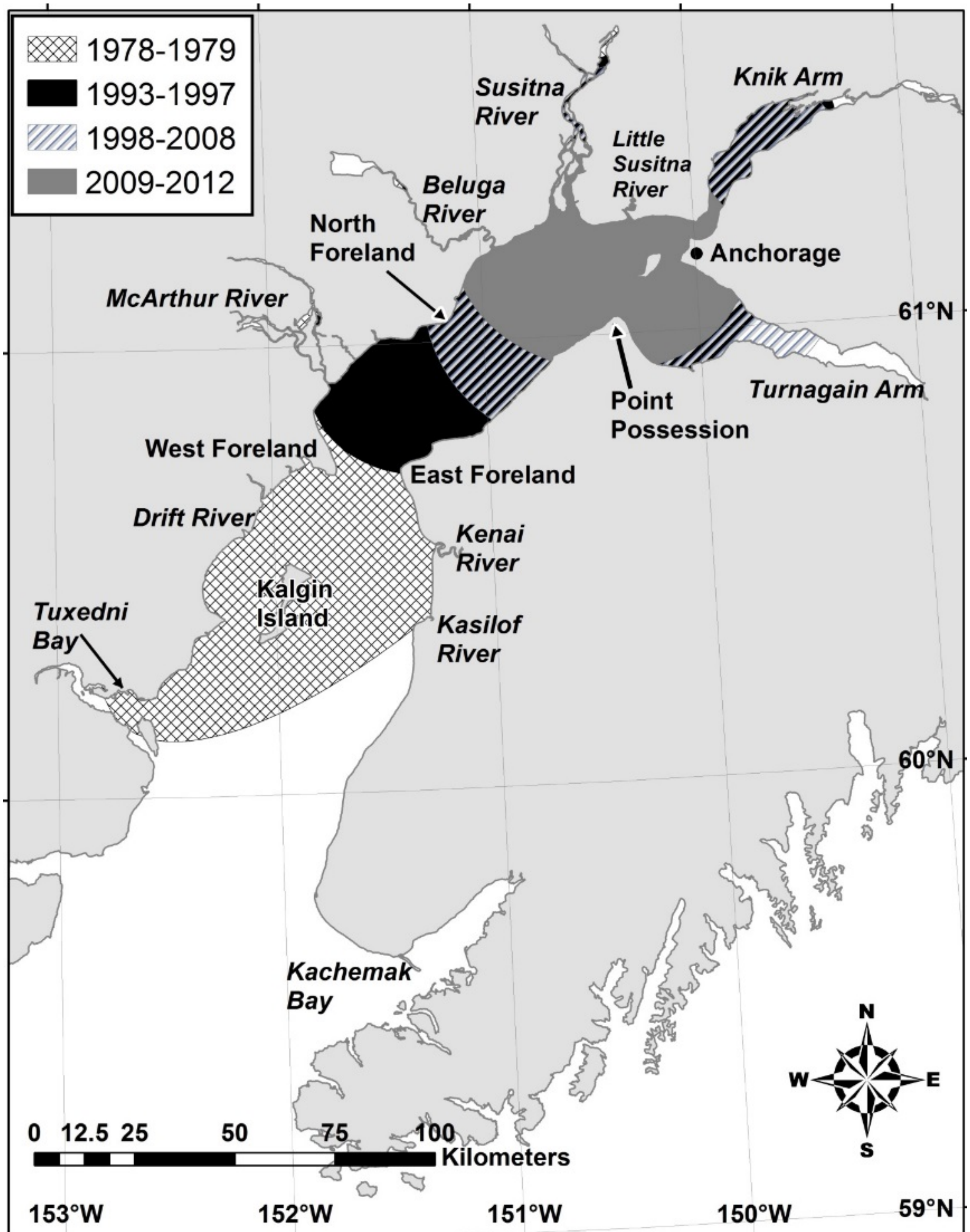

Figure 12. Summer range contraction over time as indicated by ADFG and NMFS aerial surveys. Adapted from (Shelden et al. 2015b).

Belugas may be present in the Kenai River throughout the year, however, there are peaks of beluga presence in spring (Figure 13; (Castellote et al. 2016; NMFS unpublished data)) and sightings also in the fall (August through October; NMFS unpublished data). There appears to be a steep decline in beluga presence in the Kenai River area during the summer (June through August), however historically belugas were seen throughout the summer in the area.

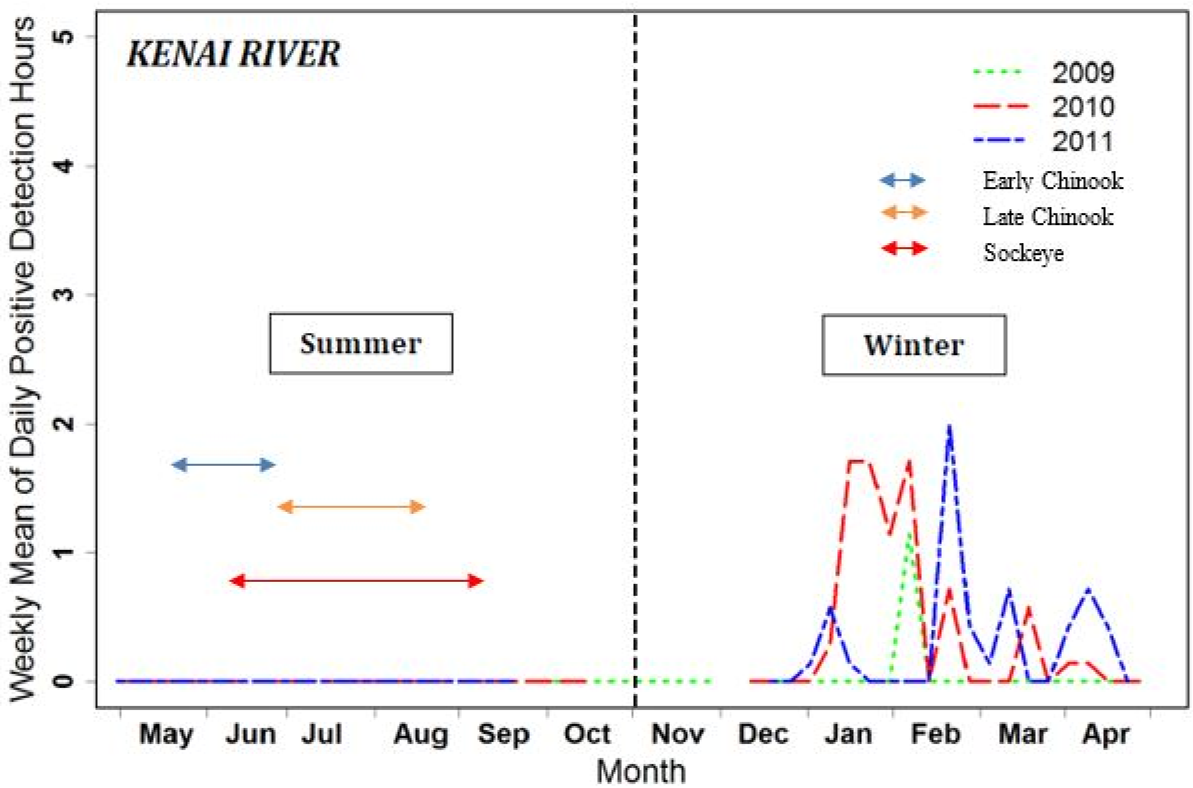

Figure 13. Acoustic detections of Cook Inlet beluga whales in the Kenai River from 2009 through 2011 compared to Chinook and Sockeye run timing. From Castellote et al. (2016) and fish run timing data at http://www.adfg.alaska.gov/sf/FishCounts/index.cfm?adfg=main.home (accessed August 3, 2017).

Cook Inlet belugas were also historically observed in the nearby Kasilof River during aerial surveys conducted by ADFG in the late 1970s and early 1980s and NMFS starting in 1993 (Shelden et al. 2015b). NMFS' records of opportunistic sightings contain thirteen records of beluga sightings in the Kasilof River between 1978 and 2015, with half of those sightings being since 2008 (Shelden et al. 2015b; NMFS unpublished data)). In 2018, surveys of local residents in the Kenai/Kasilof area were conducted by NMFS. There were two reports of belugas in the Kasilof River in April; one of these reports was of a group of around 30 belugas (NMFS unpublished data).

Additionally, belugas may be present in Tuxedni Bay throughout the year, with peaks in January and especially in March (Figure 14; (Shelden et al. 2015b, Castellote et al. 2016)). Belugas were seen in March 2018 and 2019 in Tuxedni Bay during NMFS winter distribution aerial surveys (NMFS unpublished data).

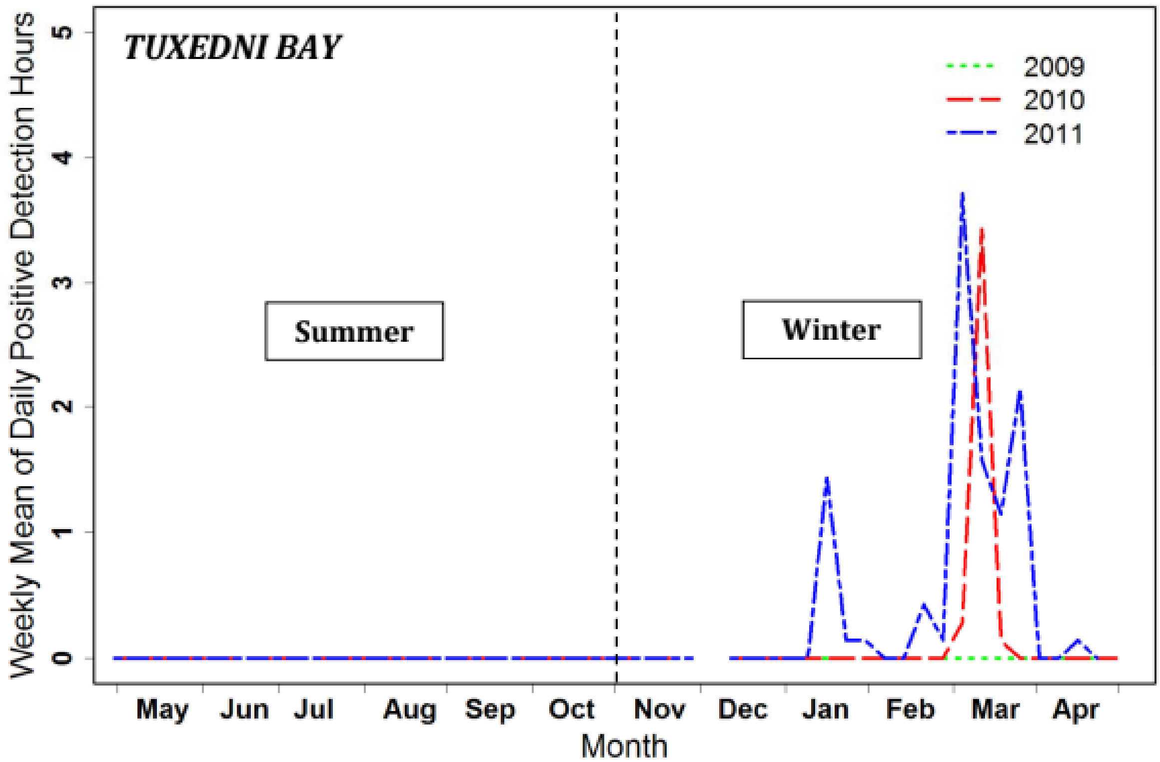

Figure 14. Detections of belugas in Tuxedni Bay using acoustic monitors from 2009-2011. (Figure 4G from Castellote et al 2015).

From December 2015 through January 2016, Tyonek Platform personnel observed 200 to 300 Cook Inlet beluga whales, including calves, regularly. They appeared to be drifting by the platform on the afternoon tides, in the open water areas between ice sheets. One operator, working in Cook Inlet for 30 years, stated that he'd never seen them in the winter before the 2015 to 16 season (S. Callaway, pers. comm. 01/19/2016). Hilcorp recently reported 143 sightings of beluga whales from May-August while conducting pipeline work in upper Cook Inlet, which is not near the area that seismic surveys are proposed but near some potential well sites (Sitkiewicz et al. 2018).

For this action, the densities of Cook Inlet beluga whales in multiple locations were based off of a habitat-based model developed by Goetz et al. (2012). The Goetz et al. (2012) model was based on sightings, depth soundings, coastal substrate type, environmental sensitivity index, anthropogenic disturbance, and anadromous fish streams to predict densities throughout Cook Inlet. The result of this work is a beluga density map of Cook Inlet, which predicts spatially explicit density estimates for Cook Inlet belugas. Figure 15 shows the Goetz et al. (2012) density estimates with the project area. Using data from the GIS files provided by NMFS and the different project locations, the resulting estimated density is shown in Table 9.

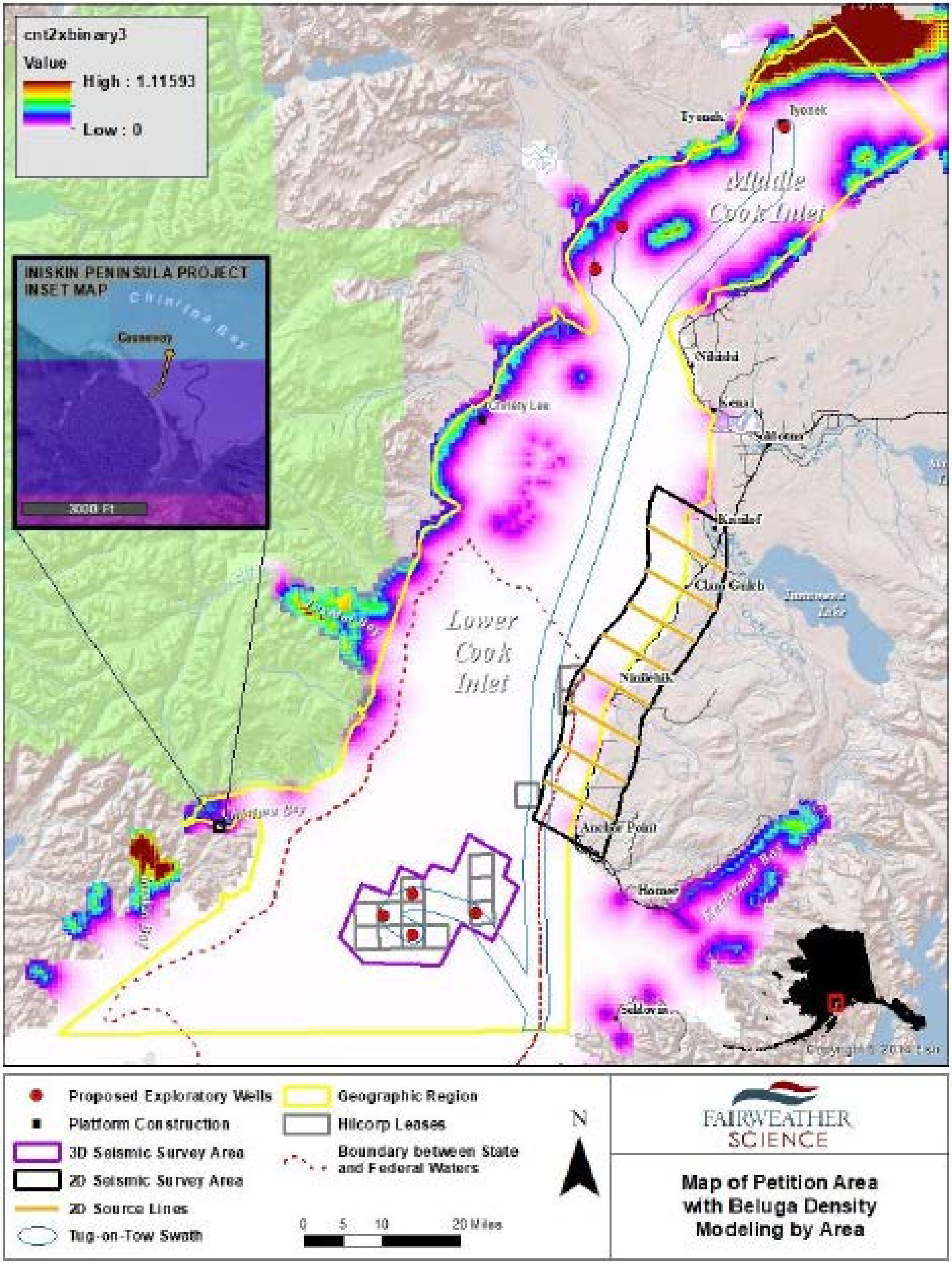

Figure 15. Beluga whale density as defined by Goetz et al. (2012) in middle and lower Cook Inlet.

Table 9. Cook Inlet beluga whale density based on the Goetz et al. (2012) habitat model in relation to project activities part of the proposed action.

Project Location	Project Activity	Beluga whale density (ind/km^2)
Lower Cook Inlet (OCS)	3D seismic, geohazard, pipe driving	0.00
Lower Cook Inlet (east side)	2D seismic	0.00-0.011106
Iniskin Bay area	Sheet pile driving	0.024362
North Cook Inlet Unit	Geohazard, pipe driving	0.001664
Trading Bay area	Geohazard, pipe driving, water jets	0.004453-0.015053

4.1.1.3 Behavior and Group Size

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 1989; NMFS unpublished data). The only known observed occurrence of calving occurred on July 20, 2015 in the Susitna Delta area (T. McGuire, 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 (Colbeck et al. 2013).

McGuire and Stephens (2017) observed increasing maximum group size of Cook Inlet beluga whales in recent years. Groups of 200 or more individuals were first seen in 2012 and the maximum group size of 313 whales – almost the entire population -- was seen in 2015 in the Susitna River Delta area. The first neonates encountered by the photo identification (ID) team during each field season from 2005 through 2015 were always seen in the Susitna River Delta in July. The photo ID team's documentation of the dates of the first neonate of each year indicate that calving begins in mid-late July/early August, generally coinciding with the observed timing of annual maximum group size. A documented observation of a beluga whale birth occurred on July 20, 2015 in the Susitna River Delta, which corroborates the importance of the Susitna River Delta as a Cook Inlet beluga whale calving ground. Probable mating behavior of belugas was observed in April and May of 2014, in Trading Bay, approximately 20 km (12 miles) west of the Furie project area (Lomac-MacNair et al. 2016).

4.1.1.4 Feeding and Prey Selection

Cook Inlet beluga whales have diverse diets (Quakenbush et al. 2015, Nelson et al. 2018), foraging on fish and benthos, often at river mouths. Belugas seasonally shift their distribution within Cook Inlet, in relation to the timing of fish runs and seasonal changes in ice and currents (NMFS 2016a). Generally, belugas spend the ice-free months in the upper Inlet, often concentrated in discrete areas such as the Susitna River Delta (McGuire and Stephens 2017), then expand their distribution south and into more offshore waters in winter (Hobbs et al. 2005). In early spring, belugas travel up to Twenty Mile River and Placer Creek in Turnagain Arm, indicating the importance of eulachon as a spring food source for belugas. Funk et al. (2005) confirmed early spring (March to May) and fall (August to October) use of Knik Arm.

In August-October, sightings increase in Knik Arm, coinciding with the coho salmon run (NMFS 2016a). In fall, many belugas disperse south, though few whales in the lower inlet are observed. In winter, belugas occur in the upper inlet as well as the lower inlet (Shelden et al. 2015b). Acoustic results suggest that some belugas may enter Knik Arm in December, January March and April, but their numbers do not markedly increase until May (Castellote et al. 2016).

A recent study using stable isotopes on historical and recent beluga bone samples suggests that the diets of Cook Inlet belugas have shifted over time (e.g., since the 1980s) to a diet influenced more by freshwater prey (Nelson et al. 2018). The cause of this dietary shift is unknown, but appears to have begun before the documented population decline.

4.1.1.5 Hearing, Vocalizations, and Other Sensory Abilities

Like other odontocete, or toothed, 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 (well within the human hearing range ; (Garland et al. 2015)), and the variety of audible whistles, squeals, clucks, mews, chirps, trills, and bell-like tones they produce have led to their nickname of “sea canaries” (ADFG 2008). Belugas and other odontocetes make sounds across some of the widest frequency bands that have been measured in any animal group.

At the higher frequency 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. Beluga whales are one of five non-human mammal species for which there is convincing evidence of frequency modulated vocal learning (Eaton 1979, Payne and Payne 1985, Tyack 1999a, Stoeger et al. 2012).

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 to 75 kHz (Figure 16).

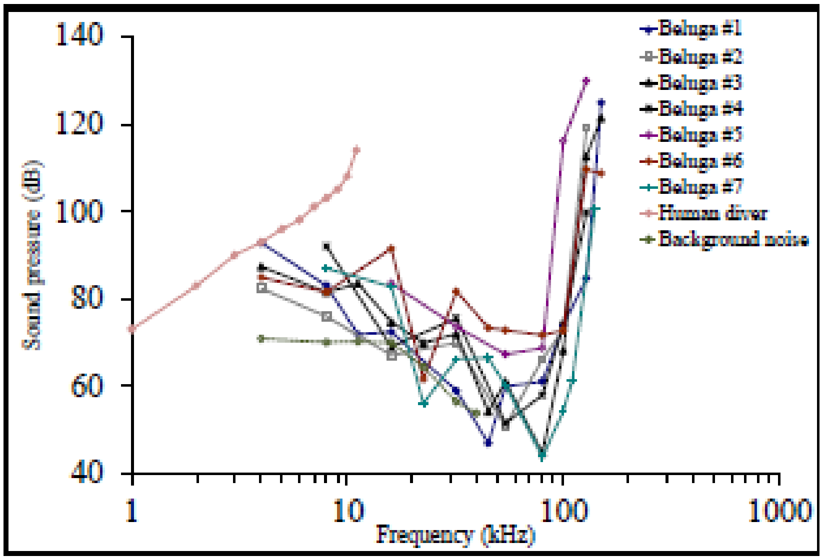

Figure 16. Audiograms of seven wild beluga whales. Human diver audiogram and Bristol Bay background noise for comparison (from Castellote et al. 2014). Results indicate that beluga whales conduct echolocation at relatively high frequencies, where their hearing is most sensitive, and communicate at frequencies, where their hearing sensitivity overlaps that of humans.

4.1.1.6 <u>Cook Inlet Beluga Whale Critical Habitat</u>

NMFS designated critical habitat for the Cook Inlet beluga whales on April 8, 2011 (Figure 17; 76 FR 20180). Critical habitat includes two areas: critical habitat Area 1 and Area 2 that together encompass 7,800 km^2 (3,013 mi^2) of marine and estuarine habitat in Cook Inlet (76 FR 20180). For national security reasons, critical habitat excludes all property and waters of Joint Elmendorf-Richardson (JBER) and waters adjacent to the Port of Alaska. Portions of critical habitat Area 1 and Area 2 exist within the action area.

Critical Habitat Area 1: Critical habitat Area 1 consists 1,909 km2 (738 mi2) of Cook Inlet, north of Threemile Creek and Point Possession (76 FR 20180). Area 1 contains shallow tidal flats or mudflats and mouths of rivers that provide important areas for foraging, calving, molting and escape from predation. High concentrations of beluga whales are often observed in these areas from spring through fall. Additionally, anthropogenic threats have the greatest potential to adversely impact beluga whales in Critical habitat Area 1 (76 FR 20180).

Critical habitat Area 2: Critical habitat Area 2 consists of 5,891 km2 (2,275 mi2) south of Critical habitat Area 1 and includes nearshore areas along western Cook Inlet and Kachemak Bay. Critical habitat Area 2 is known fall and winter foraging and transit habitat for beluga whales as well as spring and summer habitat for smaller concentrations of beluga whales (76 FR 20180).

The Cook Inlet Beluga Whale Critical Habitat Final Rule (76 FR 20180) 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.*

Although belugas may have abandoned critical habitat off of the Kenai River during the peak periods of large salmon runs, 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).

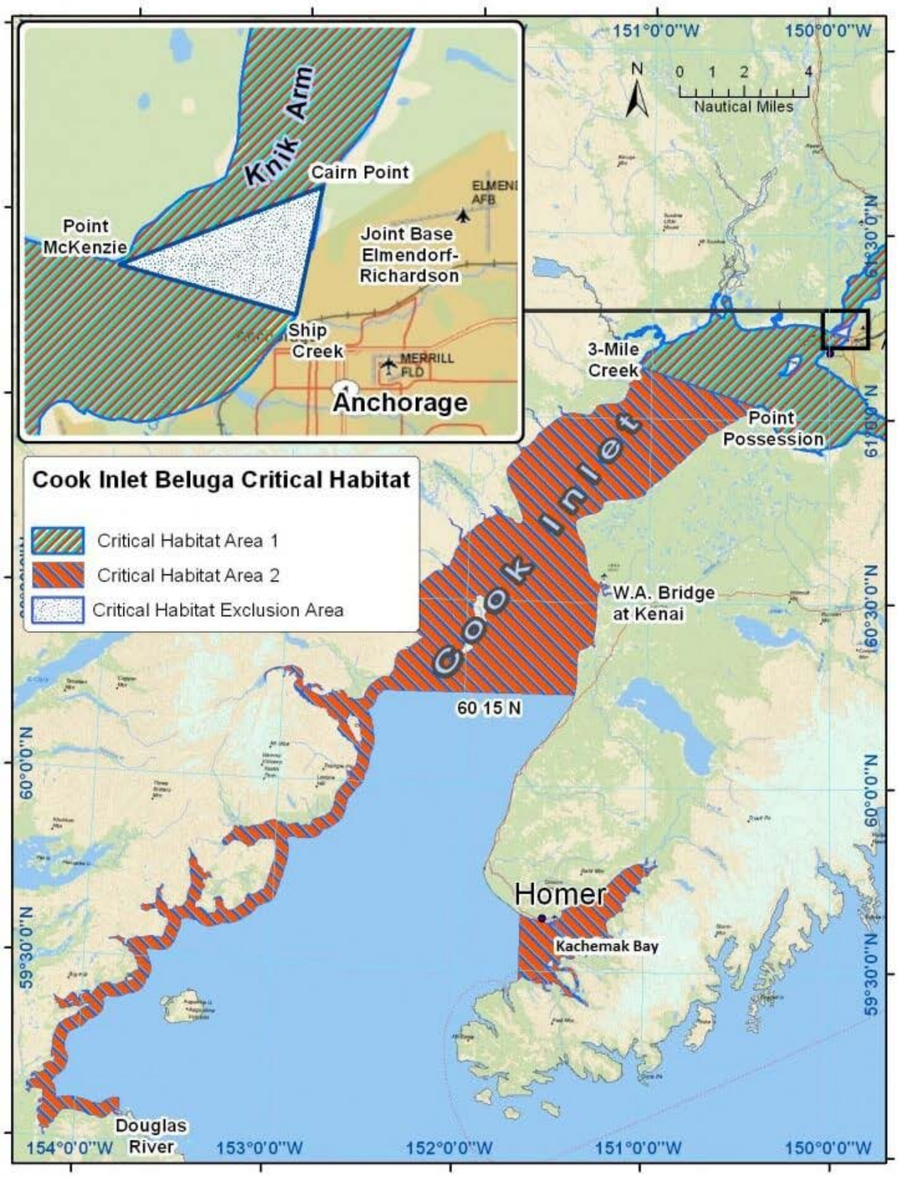

Figure 17. Designated Cook Inlet beluga critical habitat.

4.1.2 Fin Whales

The fin whale was listed as an endangered species under the Endangered Species Conservation Act (ESCA) on December 2, 1970 (35 FR 18319), and continued to be listed as endangered following passage of the ESA (39 FR 41367). Critical habitat has not been designated for fin whales. A Final Recovery Plan for the Fin Whale (*Balaenoptera physalus*) was published on July 30, 2010 (NMFS 2010c).

4.1.2.1 <u>Status and Population Structure</u>

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.

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.

NMFS recognizes three management units or “stocks” of fin whales in U.S. Pacific waters: (1) Alaska (Northeast Pacific), (2) California/Washington/Oregon, and (3) Hawaii (Muto et al. 2018). 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 Northeast 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. 2006), which resulted in an estimate of 1,652 (95 percent CI: 1,142-2,389) fin whales in the area.

In 2013 and 2015, dedicated line-transect surveys of the offshore waters of the Gulf of Alaska provided fin whale abundance estimates of 3,168 fin whales (CV = 0.26) in 2013 and 916 (CV = 0.39) in 2015. The marked differences in these estimates can be partially explained by differences in sampling coverage across the two cruises (Rone et al. 2017).

The estimates of fin whale abundance in the eastern Bering Sea and in the Gulf of Alaska are considered to be biased low due because the geographic coverage of surveys was limited relative to the range of the stock. Additionally, these surveys have not been corrected for animals missed on the trackline, animals submerged when the ship passed, and responsive movement. However, data for these corrections is not currently available, and previous studies have shown that these sources of bias are small for this species (Barlow 1995).

Zerbini et al. (2006) estimated an annual rate of increase of 4.8 percent (95 percent CI: 4.1-5.4 percent) for the period of 1987-2003, however this trend should be used with caution due to the uncertainties in the initial population estimate (1987) and the population structure of fin whales in the area. Additionally, the study represented only a small fraction of the range of the Northeast Pacific stock and it may not be appropriate to extrapolate this to a broader range.

A more recent trend in abundance estimated by Friday et al. (2013) of 14 percent (95 percent CI: 1.0-26.5 percent) annual rate of increase in abundance of fin whales from 2002 to 2010 is higher than most plausible estimates for large whale populations (Zerbini et al. 2010). This high rate of increase may be explained, at least in part, by changes in distribution (possibly driven by changes in prey distribution) rather than population growth (Muto et al. 2018).

4.1.2.2 Distribution

Fin whales are distributed widely in every ocean except the Arctic Ocean (where they have recently begun to appear). In the North Pacific, fin whales are found in summer foraging areas in the Gulf of Alaska, Bering Sea/Aleutian Islands, and as far north as the northern Chukchi Sea (Muto et al. 2018).

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 and 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). Ferguson et al. (2015) identified areas around Kodiak Island, south of the mouth of Cook Inlet, as a Biologically Important Area (BIA) for fin whale feeding (Figure 18).

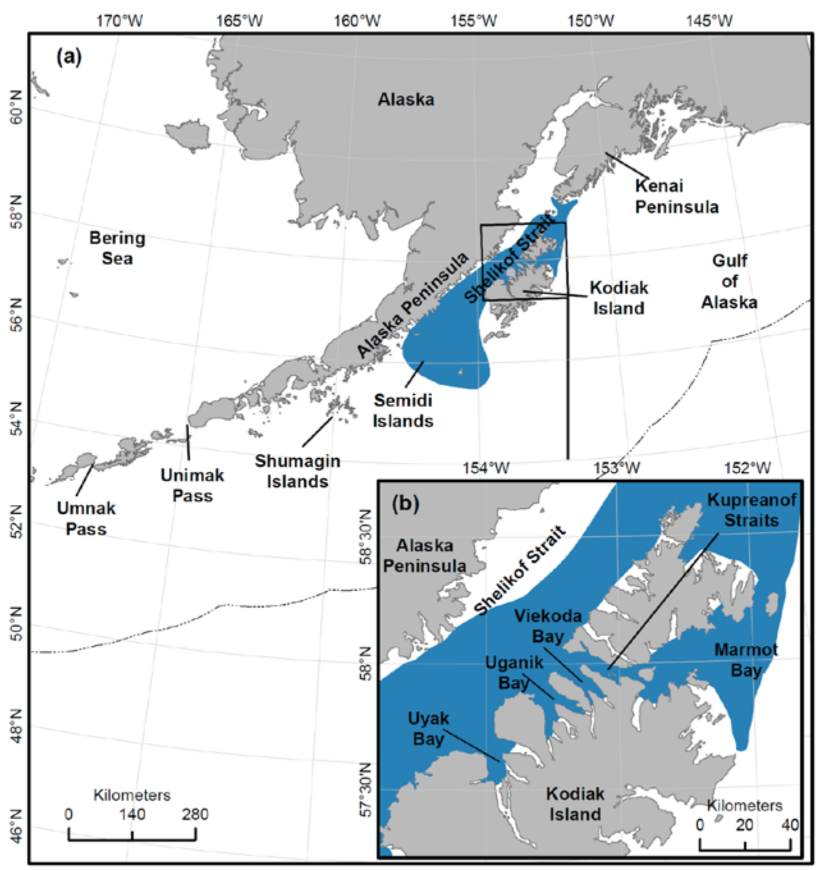

Figure 18. Fin whale Biologically Important Area for feeding identified by Ferguson et al. (2015) around Kodiak Island in the Gulf of Alaska.

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. (2008) 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.

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 2010c). Fin whales in the Cook Inlet have only been observed as individuals or in small groups.

4.1.2.3 <u>Occurrence in the Action Area</u>

An opportunistic survey conducted on the shelf of the Gulf of Alaska found fin whales concentrated west of Kodiak Island in Shelikof Strait, and in the southern Cook Inlet region. Smaller numbers were also observed over the shelf east of Kodiak to Prince William Sound (Alaska Fisheries Science Center [AFSC] 2003). In the northeastern Chukchi Sea, visual sightings and acoustic detections have been increasing, which suggests the stock may be re-occupying habitat used prior to large-scale commercial whaling (Muto et al. 2018). Most of these areas are feeding habitat for fin whales.

Fin whales are rarely observed in Cook Inlet and most sightings occur near the entrance of the inlet. During the NMFS aerial beluga whale surveys in Cook Inlet from 2000 through 2016, 10 sightings of approximately 26 individual fin whales in lower Cook Inlet were observed (Figure 19; (Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017)).

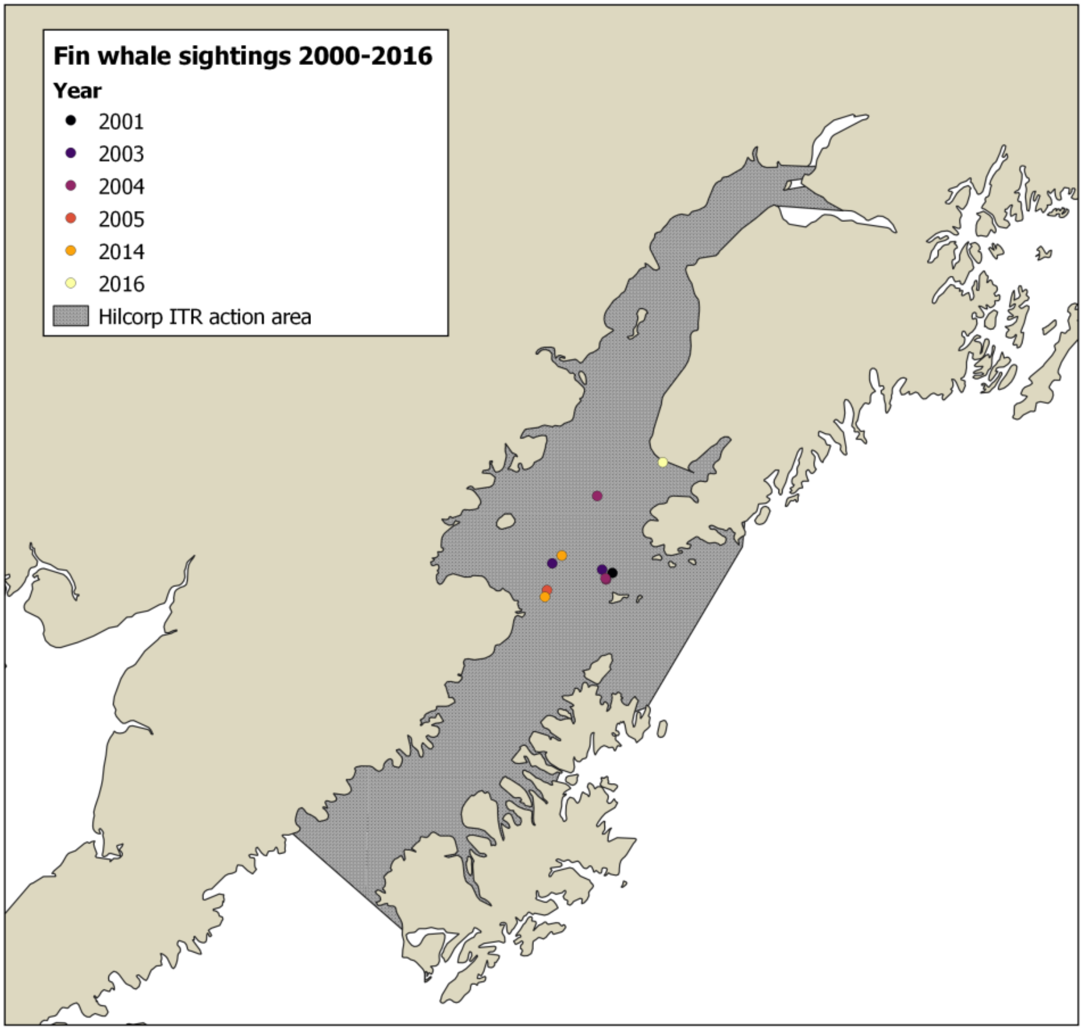

Figure 19. Fin whale sightings during aerial surveys for belugas from 2000-2016 (no fin whales were seen during 2000, 2002, 2006-2013). Sources: (Rugh et al. 2000, Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017)

For this action, the density of fin whales in the action area was estimated as 0.00033 whales/km^2 using sightings from the NMFS aerial surveys conducted for beluga whales in June between 2000 and 2016 (Rugh et al. 2000, Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017). Although there are a number of caveats to using these survey data for estimating density of species other than belugas (see Section 6 for a discussion of these caveats), they represent the best available dataset for marine mammal sightings in Cook Inlet.

4.1.2.4 Feeding and Prey Selection

In the North Pacific, 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 1980). Feeding may occur in shallow waters on prey such as sand lance (Overholtz and Nicolas 1979) and herring (Nøttestad et al. 2002), but most foraging is observed in high-productivity, upwelling, or thermal front marine waters (Panigada et al. 2008).

Fin whales, like humpback and blue whales, exhibit lunge-feeding behavior, where large amounts of water and prey are taken into the mouth and filtered through the baleen (Brodie 1993, Goldbogen et al. 2006, Goldbogen et al. 2008).

The percentage of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5 to 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. (2003) 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.).

4.1.2.5 Hearing, Vocalizations, and Other Sensory Capabilities

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 to 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 to 2s) infrasonic pulses in the 18 to 35 Hz range (Patterson and Hamilton 1964). Estimated source levels for fin whales are 140 to 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 1998). Short sequences of rapid pulses in the 20 to 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 1999b).

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 1999b). 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, or baleen whales, 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 1999b).

While there is no direct data on hearing in low-frequency cetaceans, the applied frequency range is anticipated to be between 7 Hz and 35 kHz (NMFS 2018a).

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).

4.1.3 Western North Pacific DPS and Mexico DPS Humpback Whales

Humpback whales are found in all oceans of the world with a broad geographical range from tropical to temperate waters in the Northern Hemisphere and from tropical to near-ice-edge waters in the Southern Hemisphere.

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

4.1.3.1 Status and Population Structure

In 1970, the humpback whale was listed as endangered worldwide, under the ESCA of 1969 (35 FR 18319; December 2, 1970), primarily due to overharvest by commercial whalers. Congress replaced the ESCA with the ESA in 1973, and humpback whales continued to be listed as endangered, and were considered "depleted" under the MMPA.

Following the cessation of commercial whaling, humpback whale numbers increased. NMFS conducted a global status review (Bettridge et al. 2015), and after analysis and extensive public review, NMFS published a final rule on September 8, 2016 (81 FR 62260), recognizing 14 DPSs. Four of these were designated as endangered and one as threatened, with the remaining nine not warranting ESA listing status.

Based on an analysis of migration between winter mating/calving areas and summer feeding areas using photo-identification, Wade et al. (2016) concluded that whales feeding in Alaskan waters belong primarily to the Hawaii DPS (recovered), with small numbers from the Western North Pacific DPS (endangered) and Mexico DPS (threatened) individuals. In the action area of this proposed rule (which is considered part of the Gulf of Alaska summer feeding area), we consider Hawaii DPS individuals to comprise 89 percent of the humpback whales present, Mexico DPS individuals to comprise 10.5 percent, and Western North Pacific DPS individuals to comprise 0.5 percent (Table 10).

Approximately 1,059 animals (CV=0.08) comprise the Western North Pacific DPS (Wade et al. 2016). The population trend for the Western North Pacific DPS is unknown. Humpback whales in the Western North Pacific 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 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 is 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 unless individuals have been photo-identified on breeding grounds and again on feeding grounds. All waters off the coast of Alaska may contain ESA-listed humpbacks.

Table 10. 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 Seas	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.

4.1.3.2 Distribution

Humpback whales undertake seasonal migrations from their tropical calving and breeding grounds in winter to their high-latitude feeding grounds in summer. Humpbacks may be seen at any time of year in Alaska, but most individuals winter in temperate or tropical waters near Mexico, Hawaii, and in the western Pacific near Japan. In the spring, the animals migrate back to Alaska, where food is abundant. They tend to concentrate in several areas, including Southeast Alaska, Prince William Sound, Kodiak, the mouth of Cook Inlet, and along the Aleutian Islands (Ferguson et al. 2015).

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).

4.1.3.3 Occurrence in the Action Area

Humpback whales have been observed throughout Cook Inlet, however they are primarily seen in lower and mid Cook Inlet. During the NMFS aerial beluga whale surveys between 1993-2016, there were 88 sightings of an estimated 192 individual humpback whales (Table 11 and Figure 20). A large number of these sightings occurred in the vicinity of Elizabeth Island, Iniskin and Kachemak Bays, and there were also a number of sightings north of Anchor Point (Rugh et al. 2000, Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017). Additionally, during the 2013 marine mammal monitoring program, marine mammal observers reported 29 sightings of 48 humpback whales (Owl Ridge 2014), at Cosmopolitan State well site #A-1 (on the eastern part of lower Cook Inlet, about six miles north of Ninilchik), and during the 2014 Apache seismic surveys in Cook Inlet, (north and east of the action area), marine mammal observers reported six individuals (Lomac-MacNair 2014).

Recent studies and monitoring events have also documented humpback whales further north in Cook Inlet, indicating that humpbacks occasionally use the upper Inlet and are therefore potentially present and transiting through the action area. Marine mammal monitoring conducted north of the Forelands in May and June of 2015 reported two humpback whales (Jacobs Engineering 2017). Shortly after these observations were made, a dead humpback was found in the same area, suggesting that this animal may have entered the area in a compromised state. PSOs observed two humpback whales near the mouth of Ship Creek, near Anchorage, some 31 miles (55 km) northeast of the Tyonek platform, in early September 2017 during dock renovation work (ABR 2017). In 2017, a dead humpback whale was seen floating in Knik Arm, finally beaching at Kincaid Park; necropsy results were inconclusive. Recent monitoring by Hilcorp in upper Cook Inlet during the Cook Inlet Pipeline Extension (CIPL) project also included 3 humpback whale sightings near Ladd Landing, north of the Forelands (Sitkiewicz et al. 2018). Finally, in spring 2019, a young humpback whale stranded in Turnagain Arm (NMFS unpublished data).

For this action, the density of humpback whales in the action area was estimated as 0.00189 whales/km^2 using sightings from the NMFS aerial surveys conducted for beluga whales in June between 2000 and (Rugh et al. 2000, Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017). As mentioned above, of these whales, 0.5 percent are estimated to be from the Western North Pacific DPS, and 10.5 percent from the Mexico DPS (the remaining 89 percent being from the non-listed Hawaii DPS). Although there are a number of caveats to using these survey data for estimating density of species other than belugas (Section 6), they represent the best available dataset for marine mammal sightings in Cook Inlet. These densities were also compared qualitatively to sightings in the monitoring reports mentioned above.

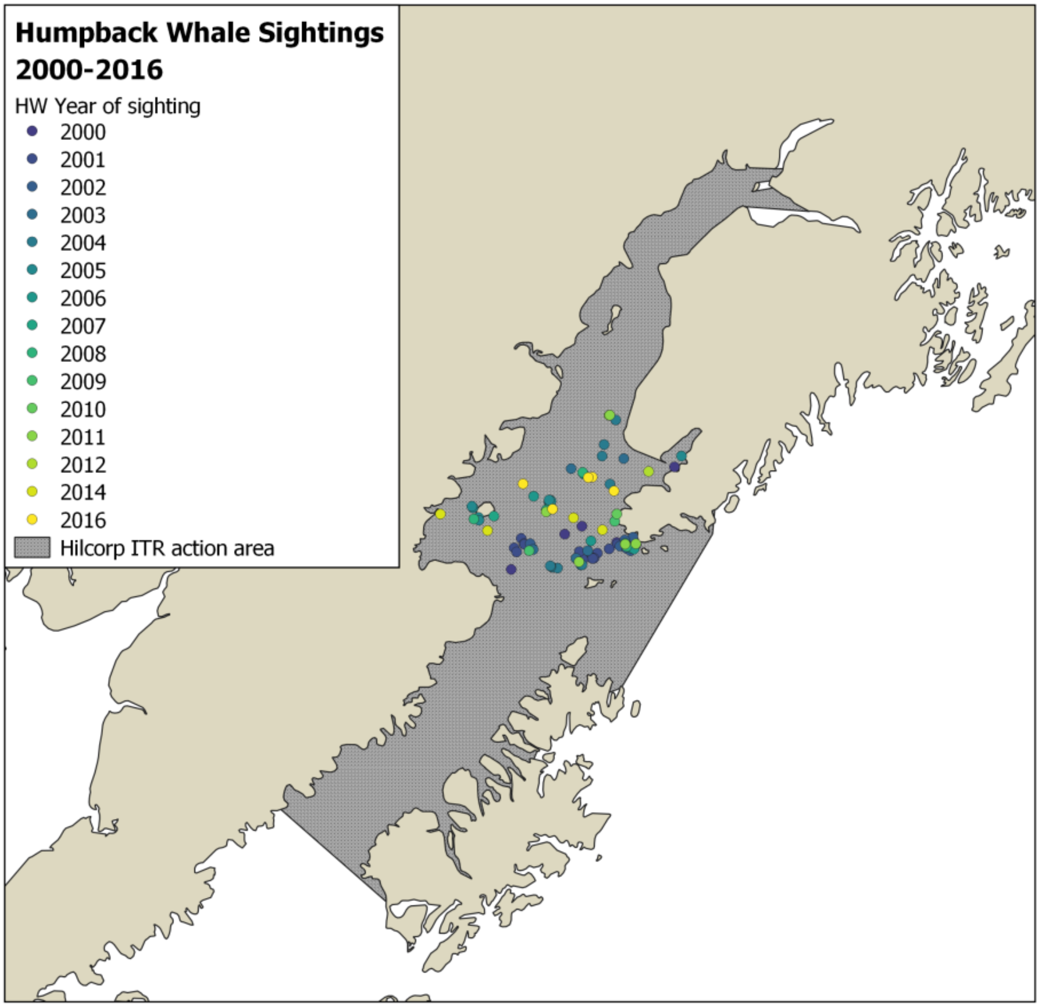

Figure 20. Humpback whale observations during aerial surveys for belugas in Cook Inlet, 2000-2016. (Rugh et al. 2000, Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017)

Table 11. Humpback whale sightings, including group size, during aerial surveys for belugas in Cook Inlet, 2000-2016.

Year[1]	Month	No. Sightings	Group Size	Location (No. whales)
2016	May	1	2	Mid-inlet, off Kachemak Bay, North of Port Graham (2)
2016	June	4	4	Mid-inlet, between Iniskin Peninsula and Kachemak Bay
2014	June	3	5	W. of Koyuktolik Island (4); Bruin Bay (1)
2014	June	1	6	S. of Augustine Island (6)
2012	May	1	1	Kachemak Bay (1)
2011	June	6	9	N. of Anchor Point, mid-inlet (3); N. of Barren Island (1); Elizabeth Island (3); E. of Augustine Island, mid-inlet
2010	June	2	4	N. of Koyuktolik Bay (4)
2009	June	1	3	N.W. of Barren Island (3)
2008	June	3	7	Elizabeth Island (5); W. of Kachemak Bay, mid-inlet (1); Augustine Island (1)
2007	June	2	3	Augustine Island (1); E. of Augustine Island, mid-inlet (2)
2006	June	7	14	S.E. Iniskin Peninsula, mid-inlet (1); W. of Kachemak Bay, mid-inlet (2); W. of Elizabeth Island (8); S. of Elizabeth Island (3)
2005	June	12	18	Kachemack Bay (1); Augustine Island (8); E. of Augustine Island, mid-inlet (6); S.E. Iniskin Peninsula, mid-inlet (3)
2004	June	10	15	W. of Kachemak Bay (3); N.W. of Barren Island (9); S.W. of Anchor Point, mid-inlet (1); N.W. of Anchor Point (2)
2003	June	5	22	Kachemak Bay (2); N.W. of Barren Island (12); N. Barren Island (3); S.W. of Anchor Point, mid-inlet (1); N.W. of Barren Island (4)
2002	June	8	20	Elizabeth Island (12); NW Barren Island (8)
2001	June	17	47	Kachemak Bay (12); N. of Barren Island (29), W. of Elizabeth Island (2), Elizabeth Island (4)
2000	June	5	11	Kachemak Bay (2); N. of Barren Island (7); E. of Shaw Island (1); W. of Elizabeth Island (1)
Total		88	191	

[1]Source: 2016 (Shelden et al. 2017), 2014 (Shelden et al. 2015), 2000-2012 (Shelden et al. 2013)

4.1.3.4 Feeding and Prey Selection

Humpback whales in the North Pacific forage in the coastal and inland waters along California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Tomilin 1967, Johnson and Wolman 1984). Of the four Biologically Important Areas (BIA) in the Gulf of Alaska described by Ferguson et al. (2015) that are important feeding areas for humpback whales, the east side of Kodiak Island is the closest to the action area (Figure 21).

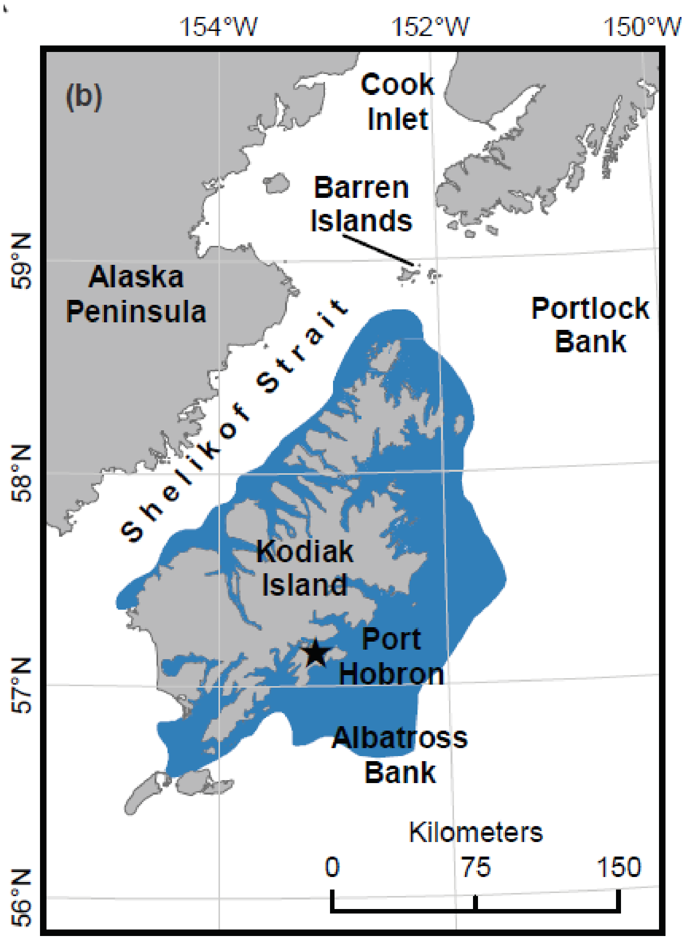

Figure 21. Seasonal humpback whale feeding BIA around Kodiak, near the mouth of Cook Inlet. During aerial surveys from 1999 to 2013, humpback whales were seen throughout the year in this area, with the greatest densities July-September (Ferguson et al 2015).

Their diverse diet is comprised of species including herring (*Clupea pallasii*), mackerel (*Scomber japonicus*), sand lance (*Ammodytes hexapterus*), juvenile walleye pollock (*Theragra chalcogramma*), capelin (*Mallotus villosus*), eulachon (*Thaleichthys pacificus*), Atka mackerel, Pacific cod (*Gadus microcephalus*), saffron cod (*Eleginus gracilis*), Arctic cod (*Boreogadus saida*), juvenile salmon (*Oncorhynchus* spp.), and rockfish (*Sebastes* spp.) (Hain et al. 1982, Baker 1985, Geraci et al. 1989).

Humpback whales exhibit flexible feeding strategies, sometimes foraging alone and sometimes cooperatively (Clapham 1993). In many locations, feeding in the water column can vary with time of day, with whales bottom feeding at night and surface feeding near dawn (Friedlaender et al. 2009). In the Northern Hemisphere, feeding behavior is varied and frequently features novel capture methods involving the creation of bubble structures to trap and corral fish; bubble nets, clouds, and curtains can be observed when humpback whales are feeding on schooling fish (Hain et al. 1982).

Humpback whales are ‘gulp’ or ‘lunge’ feeders, capturing large mouthfuls of prey during feeding rather than continuously filtering food, as may be observed in some other large baleen whales (Goldbogen et al. 2008, Simon et al. 2012). When lunge feeding, whales advance on prey with their mouths wide open, then close their mouths around the prey and trap them by forcing engulfed water out past the baleen plates.

4.1.3.5 Hearing, Vocalizations, and Other Sensory Capabilities

Because of the lack of captive subjects and logistical challenges of bringing experimental subjects into the laboratory, no direct measurements of mysticete hearing are available. Consequently, hearing in mysticetes is estimated based on other means such as vocalizations (Wartzok and Ketten 1999), anatomy (Ketten 1997, Houser et al. 2001), behavioral responses to sound (Edds-Walton 1997), and nominal natural background noise conditions in their likely frequency ranges of hearing (Clark and Ellison 2004). The combined information from these and other sources strongly suggests that mysticetes are likely most sensitive to sound from an estimated tens of hertz to ~10 kHz (Southall et al. 2007b). However, evidence suggests that humpbacks can hear sounds as low as 7 Hz up to 24 kHz, and possibly as high as 30 kHz (Ketten 1997, Au et al. 2006). These values fall within the NMFS NMFS (2018a) generalized low-frequency cetacean hearing range of 7 to 35 kHz.

Because of their size, no audiogram has been produced for humpback whales. However, Helweg et al. (2000) and Houser et al. (2001) modeled a predicted audiogram based on the relative length of the basilar membrane (within the inner ear) of a humpback whale, integrated with known data on cats and humans. The result (Figure 22) shows sensitivity to frequencies from about 700 Hz to 10 kHz, with maximum relative sensitivity between 2 to 7 kHz. Because ambient noise levels are higher at low frequencies than at mid frequencies, the absolute sound levels that humpback whales can detect below 1 kHz are probably limited by increasing levels of natural ambient noise at decreasing frequencies (Clark and Ellison 2004).

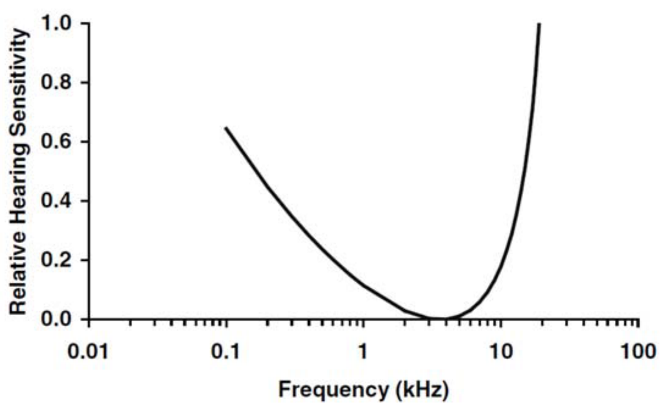

Figure 22. Predicted audiogram of humpback whale, derived by integrating the humpback frequency-position function with the sensitivity-position function derived from cat and human audiometric and anatomic data (see Houser *et al*. 2001).

4.1.4 Steller Sea Lion, Western DPS

4.1.4.1 Status and Population Structure

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 (which includes animals from east of Cape Suckling, Alaska, at 144°W longitude) was listed as threatened, and the Western DPS (which includes animals from west of Cape Suckling) was listed as endangered. On November 4, 2013, the eastern DPS was removed from the endangered species list (78 FR 66140). Information on Steller sea lion biology, threats, and habitat (including critical habitat) is available in the revised Steller Sea Lion Recovery Plan (NMFS 2008c).

As summarized most recently by Muto et al. (2018), the Western DPS of Steller sea lions decreased from an estimated 220,000 to 265,000 animals in the late 1970s to less than 50,000 in 2000. Factors that may have contributed to this decline include incidental take in fisheries, legal and illegal shooting, predation, exposure to contaminants, disease, and ocean regime shift/ climate change (NMFS 2008c). The most recent comprehensive aerial photographic and land-based surveys of Western DPS Steller sea lions in Alaska (Fritz et al. 2016, Sweeney et al. 2018) estimated a total Alaska population (both pups and non-pups) of 53,303 (Muto et al. 2018). There are strong regional differences in trends in abundance of Steller sea lions, with positive trends in the Gulf of Alaska and eastern Bering Sea east of Samalga Pass (~170°W) and generally negative trends to the west in the Aleutian Islands. The population trends in the action area (Gulf of Alaska) were observed to be increasing until 2015 (Sweeney et al. 2018), however in 2017, NMFS surveys observed anomalously low pup counts in these areas (Sweeney et al. 2018; see also Table 12). Steller sea lion surveys focused on the Gulf of Alaska are planned for 2019 (Sweeney et al. 2018).

4.1.4.2 Distribution

Steller sea lions prefer the colder temperate to sub-arctic waters of the North Pacific Ocean. They range along the North Pacific Rim from northern Japan to California, with centers of abundance in the Gulf of Alaska and Aleutian Islands (Figure 23; (Loughlin et al. 1984)). Although Steller sea lions seasonally inhabit coastal waters of Japan in the winter, breeding rookeries outside of the U.S. are located only in Russia (Burkanov and Loughlin 2005). Steller sea lions are not known to migrate annually, but individuals may widely disperse outside of the breeding season (late-May to early-July; (Jemison et al. 2013, Muto et al. 2018)).

Land sites used by Steller sea lions are referred to as rookeries and haulouts. Rookeries are used by adult sea lions for pupping, nursing, and mating during the reproductive season (generally from late May to early July). Haulouts are used by all age classes of both genders but are generally not where sea lions reproduce. Sea lions move on and offshore for feeding excursions. At the end of the reproductive season, some females may move with their pups to other haulout sites and males may migrate to distant foraging locations (Spalding 1964, Pitcher and Calkins 1981). Sea lions may make semi-permanent or permanent one-way movements from one site to another (Chumbley et al. 1997, Burkanov and Loughlin 2005). Round trip migrations of greater than 6,500 km by individual Steller sea lions have been documented (Jemison et al. 2013).

Most adult Steller sea lions occupy rookeries during the pupping and breeding season, which extends from late May to early July (Pitcher and Calkins 1981, Gisiner 1985), and exhibit high site fidelity (Sandegren 1970). During the breeding season some juveniles and non-breeding adults occur at or near the rookeries, but most are on haulouts (Rice 1998, Ban 2005, Call and Loughlin 2005).

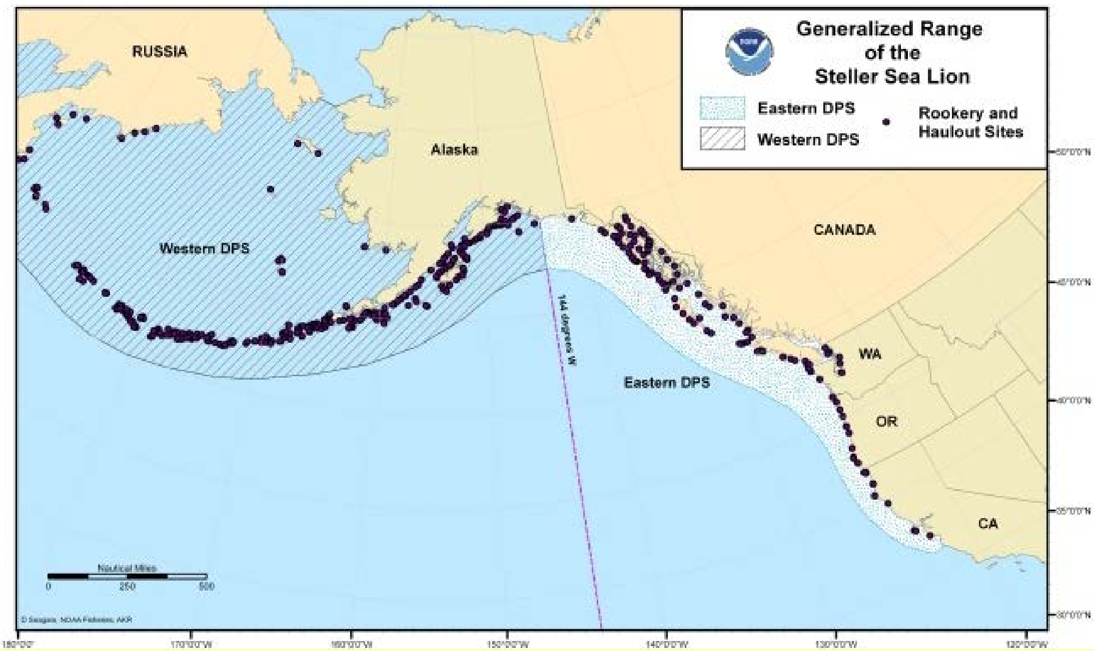

Figure 23. Generalized ranges of WDPS and EDPS Steller sea lions

4.1.4.3 Occurrence in the Action Area

Steller sea lions can be found throughout the action area, however they are more frequently observed in the mid and lower Inlet (Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017). Hilcorp recently reported 1 sighting of 2 Steller sea lions while conducting pipeline work in upper Cook Inlet (Sitkiewicz et al. 2018).

The most recent available counts of Western DPS Steller sea lions observed on rookeries and haulouts within the action area (from 2017) are shown in Table 12, with the location of these sites shown in (Figure 24). About 3,600 sea lions use terrestrial sites in the action area, with additional individuals venturing into the area to forage. As mentioned above, NMFS plans to conduct Steller sea lion surveys focused on the Gulf of Alaska, including these sites, in 2019.

In 2012, during Apache's 3D Seismic surveys, there were three sightings of approximately four individuals in upper Cook Inlet (Lomac-MacNair et al. 2013). Marine mammal observers associated with Buccaneer's drilling project off Cape Starichkof observed seven Steller sea lions during the summer of 2013 (Owl Ridge 2014). During SAExploration's 3D Seismic Program in 2015, four Steller sea lions were observed in Cook Inlet. One sighting occurred between the West and East Forelands, one near Nikiski and one northeast of the North Foreland in the center of Cook Inlet (Kendall et al. 2015). One Steller sea lion was observed near Ladd Landing for the

Harvest Alaska CIPL project during the summer (Sitkiewicz et al. 2018).

For this action, the density of Steller sea lions in the action area was estimated as0.00811 seal lions/km^2 using sightings from the NMFS aerial surveys conducted for beluga whales in June between 2000 and 2016 (Rugh et al. 2000, Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017). As with fin and humpback whales, although there are a number of caveats to using these survey data for estimating density of species other than belugas (Section 6), they represent the best available dataset for marine mammal sightings in Cook Inlet. These densities were also compared qualitatively to sightings in the monitoring reports from other projects in Cook Inlet (e.g., SAE, Apache, Hilcorp Cook Inlet Pipeline, etc.).

Table 12. Breeding season aerial survey counts (2017) of Steller sea lion non-pups and pups at sites within the action area. Source: Sweeney et al. 2017. Sites shaded in gray are part of designated critical habitat (see Figure 25 and Figure 26)

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	17	0	Shakun Rocks	214	3
Elizabeth/Cape Elizabeth	0		Kodiak/Cape Ugat	392	0
Afognak/Tonki Cape	0		Kodiak/Cape Kuliuk	0	
Flat	0		Cape Nukshak	0	
West Amatuli	0		Cape Ugyak	0	
Sugarloaf	980	682	Cape Gull	50	0
Sea Otter/Rk Near	0		Cape Kuliak	36	
Sud	0		Kodiak/Cape Uyak	0	
Sea Otter	204	1	Takli	1	0
Ushagat/Nw	0	0	Kodiak/Sturgeon Head	0	
Ushagat/Rocks South	56	0	Kodiak/Cape Ikolik	47	0
Ushagat/Sw	417	97	Kodiak/Tombstone Rocks	0	
Latax Rocks	366	12	Puale Bay	292	0
Kodiak/Cape Paramanof	0		**Total Counts**	**3,173**	**795**
Kodiak/Steep Cape	57	0			

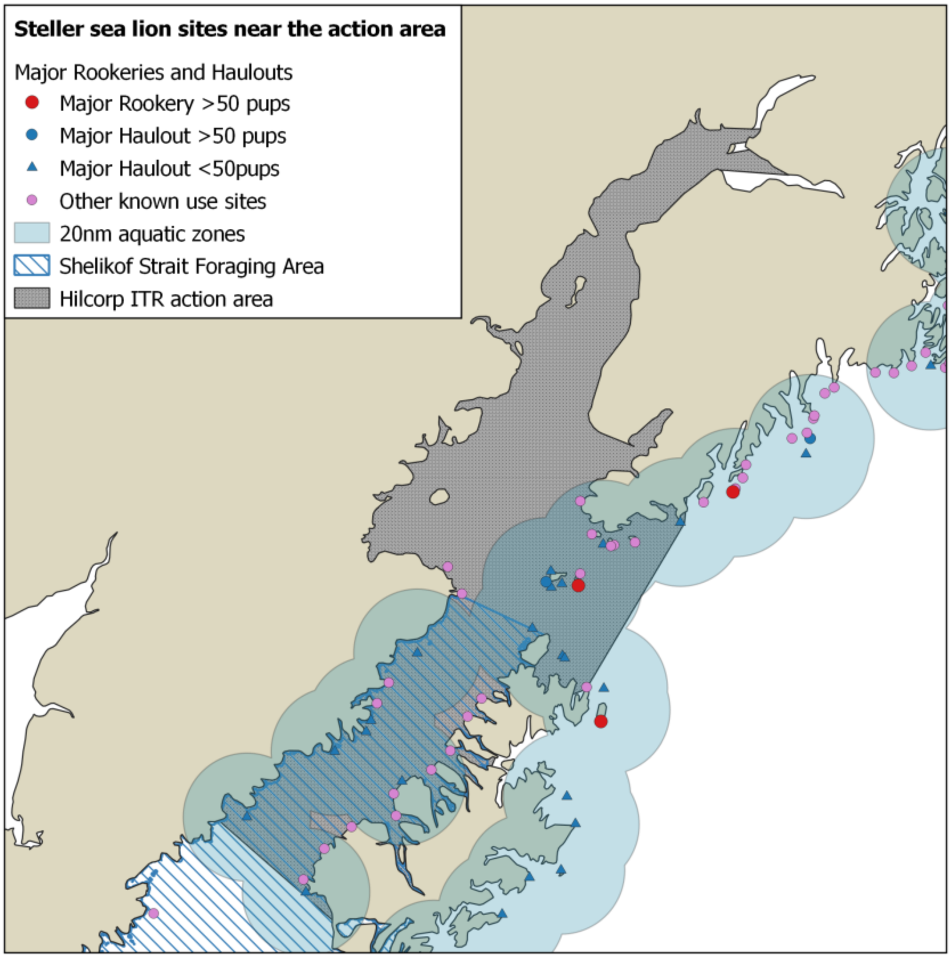

Figure 24. Steller sea lion sites near the action area. Designated critical habitat (50 CFR 226.202) includes the major rookeries, major haulouts, 20nm aquatic zones around major rookeries and haulouts, and the Shelikof Strait aquatic foraging area.

<u>4.1.4.4 Feeding and Prey Selection</u>

The foraging strategy of Steller sea lions is strongly influenced by seasonality of sea lion reproductive activities on rookeries, and the ephemeral nature of many prey species. Steller sea lions are generalist predators that eat a variety of fishes and cephalopods (Pitcher and Calkins 1981, Calkins and Goodwin 1988, NMFS 2008c) and occasionally other marine mammals and birds (Pitcher and Fay 1982, NMFS 2008c).

During summer Steller sea lions feed mostly over the continental shelf and shelf edge. Females attending pups forage within 20 nm of breeding rookeries (Merrick and Loughlin 1997), which is the basis for designated critical habitat around rookeries and major haulout sites.

Steller sea lions tend to make shallow dives of less than 250 m (820 ft) but are capable of deeper dives (NMFS 2008c). Female foraging trips during winter tend to be longer in duration and farther from shore (130 km), 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 to 250 m; (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 (Merrick and 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.

4.1.4.5 Hearing, Vocalizations, and Other Sensory Abilities

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 2018a). Studies of Steller sea lion auditory sensitivities have found that this species detects sounds underwater between 1 to 25 kHz (Kastelein et al. 2005), and in air between 250 Hz and 30 kHz (Mulsow and Reichmuth 2010). Sound signals from vessels are anticipated to be within the hearing range of Steller sea lions, whether the animals are in the water or hauled out.

4.1.4.6 Steller sea lion Critical Habitat

NMFS designated critical habitat for the Steller sea lion on August 27, 1993 (58 FR 45269), citing the physical and biological habitat features that support reproduction, foraging, rest, and refuge, including terrestrial, air, and aquatic zones. Steller sea lion critical habitat west of 144°W (Figure 25) includes a 20 nautical mile buffer around all major haulouts and rookeries, as well as associated terrestrial, air, and aquatic zones, and three large offshore foraging areas (Shelikof Strait, Bogoslof, and Seguam Pass). The 20-mile critical habitat radii around haulouts and rookeries serve to minimize disturbance around these important areas and also to provide an adequate food supply close to rookeries for lactating females, who alternate foraging trips at sea with nursing their pups on land. East of 144°W, Steller sea lion critical habitat includes aquatic areas 3,000 ft (0.9 km) seaward of each major haulout and major rookery.

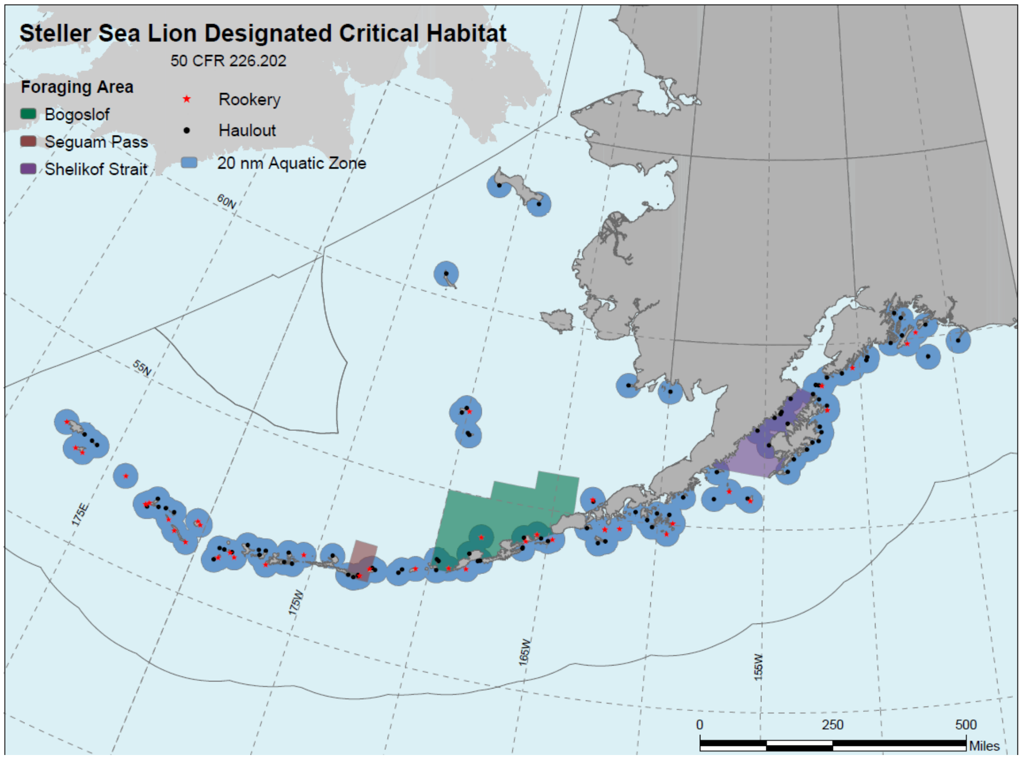

Figure 25. Designated Steller sea lion critical habitat west of 144°W.

The action area overlaps with a small portion of Steller sea lion critical habitat, including portions of the 20-nautical mile buffers of 16 major haulouts and 1 major rookery (Table 12 and Figure 26).

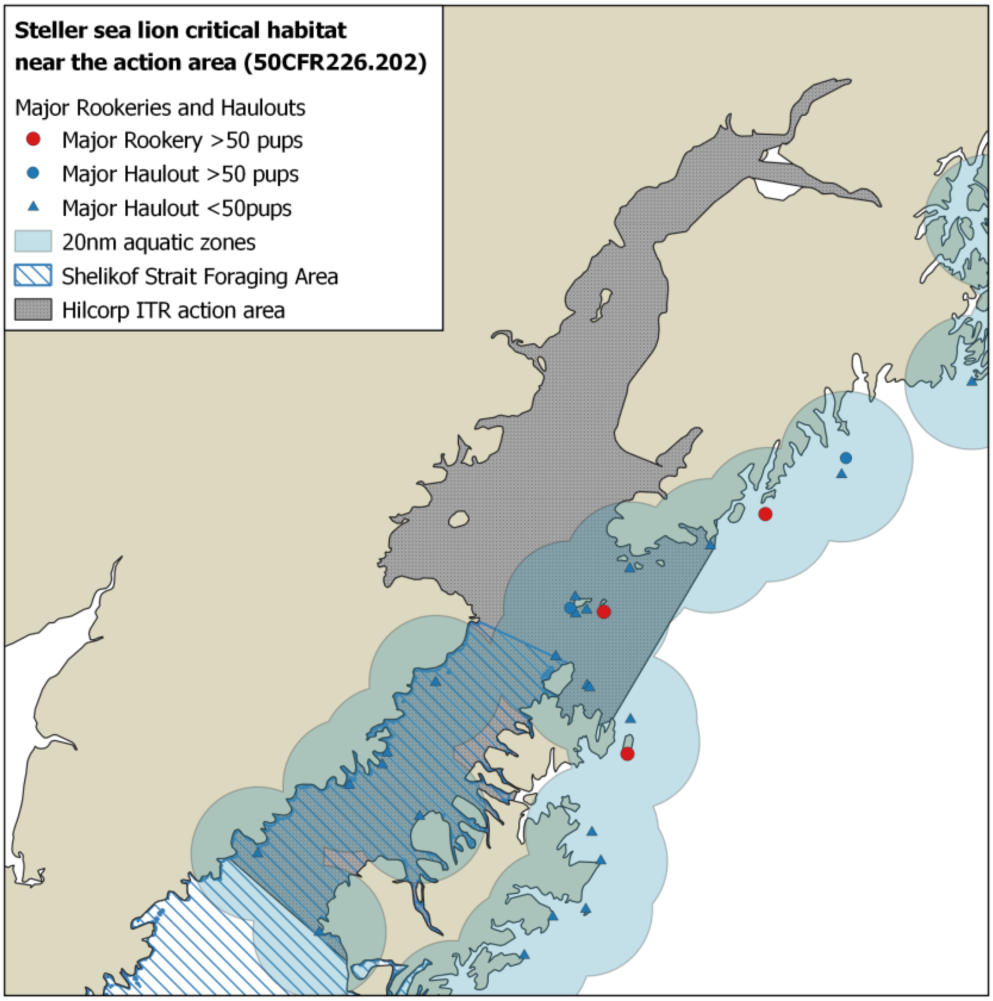

Figure 26. Designated Steller sea lion critical habitat near the action area.

NMFS identified physical and biological features essential for conservation of Steller sea lions in the final rule to designate critical habitat (58 FR 45269). The proposed project may affect Steller sea lion critical habitat through vessel disturbance and exposure to potentially harmful materials.

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°W longitude.

4. Aquatic zones that extend 20 nautical miles seaward from each major rookery and major haulout west of 144°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).

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 discusses the environmental baseline, focusing on existing anthropogenic and natural activities within the action area and their influences on species and their critical habitat that may be adversely affected by the proposed action. Species and critical habitat that may be affected by the proposed action include Cook Inlet beluga whales, Cook Inlet beluga whale critical habitat, Western DPS humpback whales, Mexico DPS humpback whales, fin whales, Western DPS Steller sea lions, and Steller sea lion critical habitat. Although some of the activities discussed below are outside the action area, they may still have an influence on listed species or their habitat in the action area.

The listed species, as well as other resident marine mammal species, may be impacted by a number of anthropogenic activities present in Cook Inlet. Over 65 percent of Alaska's human population (737,080) resides within southcentral Alaska or the Cook Inlet region (Alaska Department of Labor and Workforce Development 2019). The high degree of human activity, especially within upper Cook Inlet, has produced a number of anthropogenic risk factors that marine mammals must contend with, including: coastal and marine development, oil and gas development, ship strikes, noise pollution, water pollution, prey reduction, direct mortalities, and research, in addition to factors operating on a larger scale such as predation, disease, and environmental change. The species may be affected by multiple threats at any given time, compounding the impacts of the individual threats. Anthropogenic risk factors are discussed individually below.

5.1 Coastal Development

Beluga whales and Steller sea lions use nearshore environments to rest, feed, and breed and thus could be affected by any coastal development that impacts these activities. Humpback and fin whales occupy areas offshore and are less likely affected by coastal development.

Alaska population projections anticipate about a 34 percent growth in the populations of Anchorage/Mat-Su and the Kenai Borough over the next 30 years (Robinson et al. 2018). As the population continues to grow, coastal development will continue to result in the loss of habitat, increased vessel traffic, increased pollutants, and increased noise associated with construction and maintenance activities. Any projects requiring Federal authorization or funding (e.g., Chuitna Coal Mine, Ocean Renewable Power Company (ORPC) Tidal Energy Projects, Port of Alaska (POA) expansions) will undergo section 7 consultation. However as populations in the area increase, coastal development with unspecified impacts to Cook Inlet are likely to occur.

Some development has resulted in both the direct loss of habitat from construction of roads, housing or other shoreline developments, and indirect loss associated with bridges, boat traffic, in-water noise, and discharges that affect water quality. 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.

While the majority of the Cook Inlet shoreline is undeveloped, there are municipalities, port facilities, airports, wastewater treatment plants, roads, mixing zones, and railroads that occur along or close to the shoreline (Figure 27). Knik Arm supports the largest port and military base in the state. Construction in Cook Inlet associated with coastal development includes dredging (e.g., at the Port of Alaska[4]), and pile driving (e.g., at the Port of Alaska, Ship Creek boat launch, Port MacKenzie, several small projects in the Kachemak Bay area, and oil and gas development). Significant construction projects in Cook Inlet are discussed in the following sections, many of which have undergone separate section 7 consultations. In this section, we describe the physical aspects of development; noise aspects of development are discussed in Section 5.3.

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 2010a).

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 2008a, 2016a). 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

[4] The Anchorage Assembly voted Oct. 24, 2017 to rename the Port of Anchorage as the Port of Alaska in a move to emphasize the importance of the infrastructure to the entire state rather than just its largest city.

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) beginning in 2015. These activities included geophysical and geotechnical testing, on-shore blasting, pile removal and installation at stream crossings, fill placed into Turnagain Arm to facilitate roadway straightening, and construction of a boat ramp at Windy Point 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 from April 6 to April 23, 2015. Even though no in-water activities occurred at night (at Twentymile Bridge), roadway flaggers present throughout the night indicated they could hear beluga whales at the bridge site during nighttime hours. During the 2015 season, there were 18 observations of beluga whale groups, ranging in size from 3-30. 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). Frequent sightings of belugas at the mouth of the Twentymile River are consistent with 2018 observations reported by the Beluga Whale Alliance where, from August 10-Oct. 9, belugas were observed at the Twentymile River mouth on 12 of 22 occasions (Beluga Whale Alliance, unpublished data).

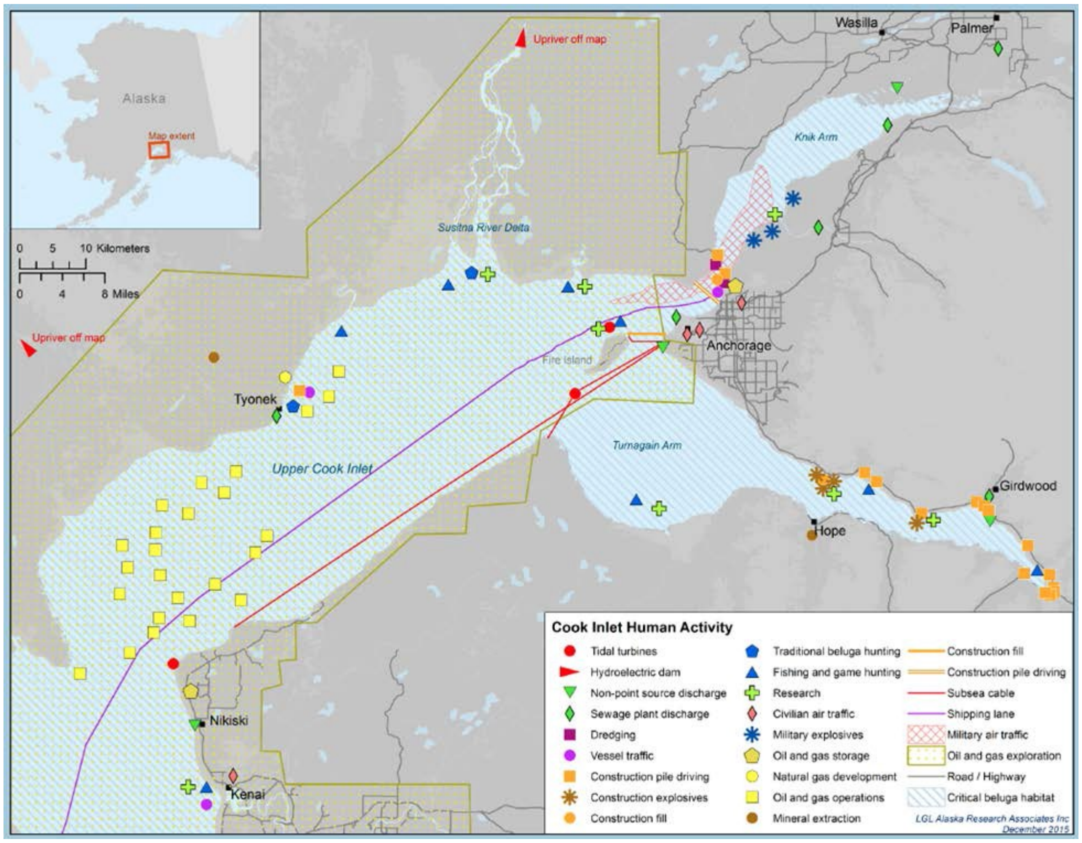

Figure 27. Development and anthropogenic activities in Cook Inlet (LGL 2015, unpublished data).

5.1.2 Port Facilities

Cook Inlet is home to port facilities at Anchorage, Point Mackenzie, Nikiski, Kenai, Homer, Seldovia, and Port Graham; barge landings are present at Tyonek, Drift River, and Anchor Point. Anchorage has a small boat ramp near Ship Creek, which was renovated in 2017. It is the only hardened public access boat ramp in Upper Cook Inlet. However, numerous other boat launch sites (e.g., beach launch at Tyonek, Captain Cook State Recreation Area, City of Kenai boat launch, multiple boat launch locations near the mouth of the Kenai River, and Kasilof River State Recreation Site) provide Cook Inlet access to small boats.

<u>Port of Alaska</u>
The Port of Alaska (POA, previously referred to as the Port of Anchorage) is Alaska's largest seaport and provides 90 percent of the consumer goods for about 85 percent of all 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, located in Anchorage. 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 (USACE 2009). The Port of Alaska 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 disturbance zones, and a single Steller sea lion was sighted at the facility.

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.[5] During the course of this project, belugas entered the Level B exclusion zone on 9 occasions. 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). Shoreline stabilization in the northern port area is expected to begin in the near future.

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 2009), and belugas often pass near the dredge.

Castellote et al. (2016) reports that weekly mean of daily beluga detection-positive hours (DPH) from Cairn Point, Point MacKenzie, and Six Mile are very low compared to the DPH obtained in the upper part of Knik Arm. When assessing the effects of construction noise at the POA, Kendall et al. (2014) offered several explanations for low beluga detections there:

- belugas might be displaced from the east side of the lower Knik Arm due to construction activities at the POA, or
- belugas might reduce their vocal activity when transiting through this area, or
- beluga acoustic signals might be masked by anthropogenic noise.

There is evidence of a decrease or even a cessation of acoustic activity by 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. The very low rate of acoustic detection in this area compared to upper Knik Arm supports the hypothesis that anthropogenic sound may be contributing to reduced acoustic output from Cook Inlet belugas.

Port MacKenzie

Port MacKenzie is along western lower Knik Arm. Coastal development at this site began in 2000 with the construction of a barge dock. Additional construction and bulkhead repair activity has occurred since then; 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 may include dry bulk cargo movement and storage, depending on the current state of the port and existing demand for

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[5] The Port had plans to begin construction of a petroleum-cement terminal in 2018, but this project has been delayed until 2019.

its facilities. 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 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. No pile driving was occurring during any of these close approaches, so no takes occurred and no shut-downs were ordered (LLC 2016).

Other Ports

The Drift River Terminal facility in Redoubt Bay 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. The Drift River Terminal had an original storage capacity of up to six million gallons of crude oil. In 2009, a volcanic eruption of Mt. Redoubt forced the evacuation of the terminal and a draw-down of oil stored on-site (Alaska Journal of Commerce 2009). Hilcorp bought the facility in 2012 and, after numerous improvements, partially reopened the facility to oil storage and tanker loading operations. The proposed action includes decommissioning of the Drift River Terminal in 2023 if the pipeline between the Drift River Terminal and Christy Lee is abandoned prior to 2025.

Nikiski is home to several privately owned docks including the Offshore Systems Kenai (OSK). 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 Rig Tenders Dock in Nikiski, in anticipation of increased oil and gas activity in Cook Inlet and to accommodate oil and gas development in the Chukchi and Beaufort seas.

Ladd Landing Beach, located near Tyonek, serves as public access to the Three Mile subdivision and a staging area for various commercial fishing sites in the area.

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. Kodiak harbor is not in the action area of this project.

Eley (2012) estimated that large ship port calls could increase by 40 percent (200 ships per year) with the construction of the Alaska LNG gas pipe line and full development of Port Mackenzie and Ladd's Landing (Eley 2012).

5.2 Oil and Gas Development

Cook Inlet is estimated to have 500 million barrels of oil and over 19 trillion cubic feet of natural gas that are undiscovered and technically recoverable (Wiggin 2017). Schenk et al. (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.

Lease sales for oil and gas development in Cook Inlet began in 1959 (Alaska Department of Natural Resources 2014). 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 17 offshore oil and gas platforms in Cook Inlet. Figure 28 shows the ongoing oil and gas activities in state waters as of October 2018. Active oil and gas leases in Cook Inlet total 214 leases encompassing approximately 456,829 acres of State leased land of which 317,004 acres are offshore[6] (Figure 29).

In 2017, BOEM held Lease Sale #244 in Cook Inlet (Figure 30). Hilcorp was the only company responding, submitting bids on 14 of 224 tracts/Blocks offered; their successful bids encompass 31,005 acres. The proposed activities in these ITRs will occur, in part, within these blocks (Figure 10).

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 listed marine mammals are unknown (NMFS 2008a, c). The Cook Inlet beluga Recovery Plan identified potential impacts from oil and gas development including 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 2016a).

[6] http://dog.dnr.alaska.gov/documents/leasing/periodicreports/lease_lasactiveleaseinventory.pdf; accessed 3/27/2019

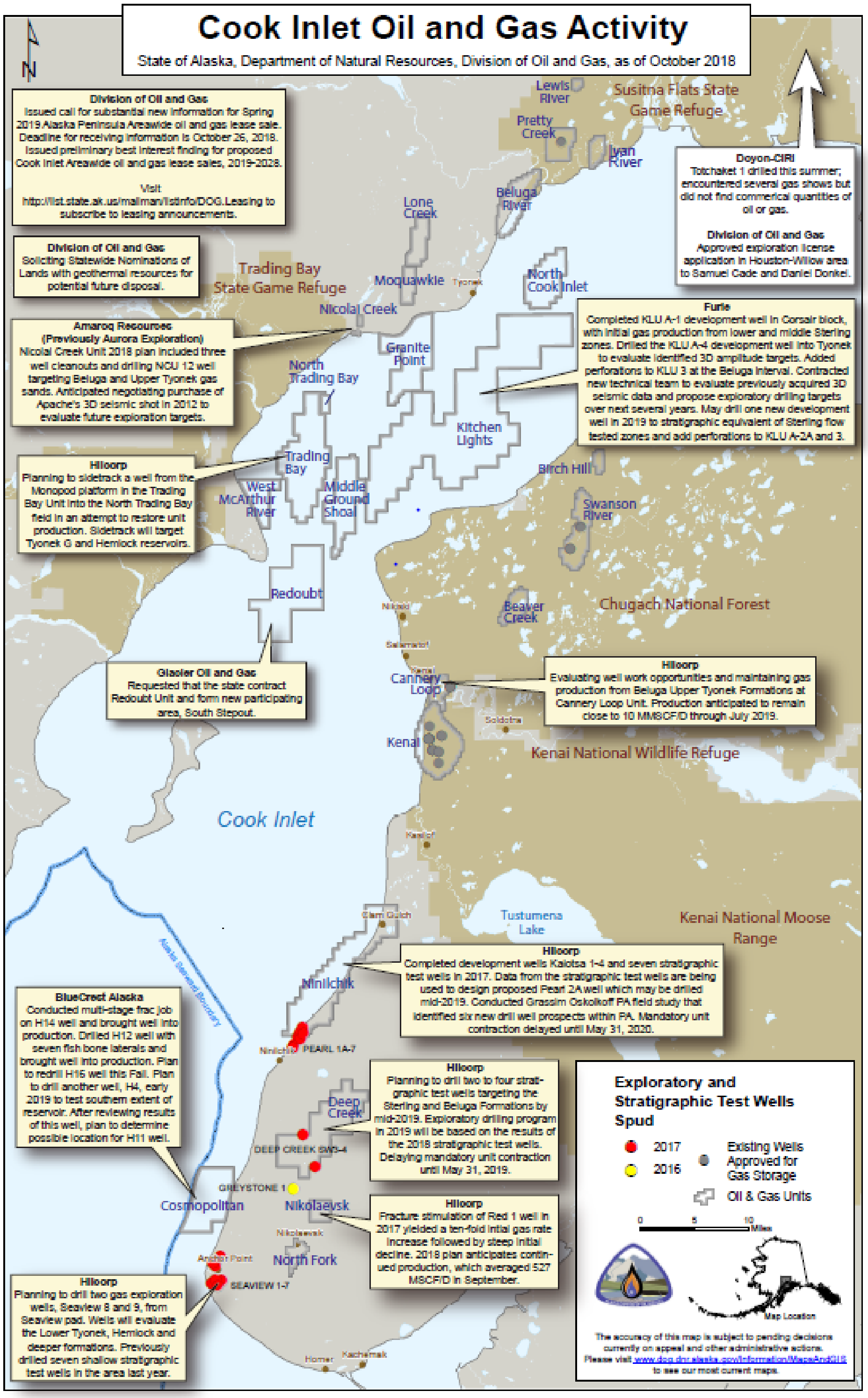

Figure 28. Oil and gas activity in Cook Inlet as of October, 2018.

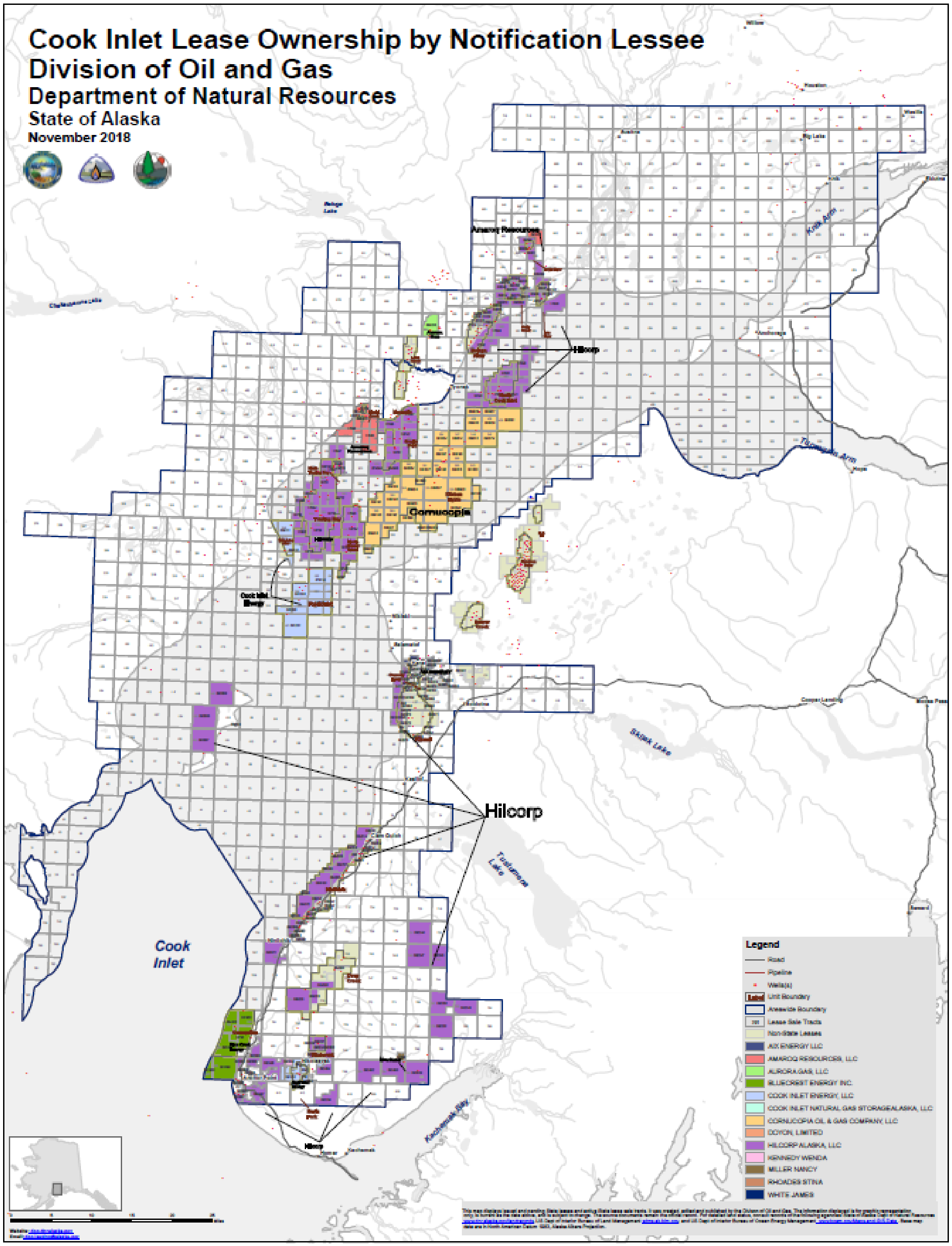

Figure 29. Cook Inlet Lease Ownership by Notification Lessee
http://dog.dnr.alaska.gov/Documents/Maps/CookInlet_NotificationLesseNov2018_Labeled.pdf

5.3 Underwater Installations

Pipelines are an essential part of oil and gas activities in Cook Inlet. 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 (Alaska Department of Natural Resources 2017). The possibility of pipeline failures are always associated with oil and gas development, with the associated possibility of oil spills, gas leaks, or other sources of marine petrochemical contamination.

Trans-Foreland Pipeline

In 2014, the Trans-Foreland Pipeline Co. LLC (owned by Tesoro Alaska) received approval from state, Federal (including NMFS section 7 AKR-2014-9394), 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. This pipeline has not been constructed.

Hilcorp Cook Inlet Pipeline Cross Inlet Extension

In 2018, Hilcorp was issued an incidental harassment authorization (IHA) to Harvest Alaska, LLC (Harvest), associated with their 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. The IHA authorized Hilcorp to incidentally take, by Level B harassment, 40 Cook Inlet beluga whales, 6 Steller sea lions, and 5 humpback whales (NMFS 2018d).

Alaska LNG Project

The Alaska LNG (AK LNG) Project is being designed to carry natural gas from the North Slope to southcentral Alaska and for export internationally. Proposed infrastructure includes an 800-mile long, large diameter pipeline from the North Slope that would cross Cook Inlet north of the Forelands and terminate at a liquefaction facility proposed at the Nikiski area on the Kenai Peninsula. This project could eventually ship up to 2.4 billion cubic feet of liquefied natural gas (LNG) per day. The Alaska Gasline Development Corporation (AGDC) has applied for MMPA authorization for the Cook Inlet portion of the project, and the Federal Energy Regulatory Commission (FERC) is in the process of writing the Draft Environmental Impact Assessment, with the final authorizations, including the MMPA permits and ESA consultation, expected in 2020.

The existing Kenai LNG liquefaction and terminal complex adjacent to the coast of Cook Inlet began operating in 1969. Until 2012, it was the only facility in the United States authorized to export LNG produced from domestic natural gas. With LNG shipments from the terminal declining, the terminal's owner announced in mid-2017 that it would put the plant in long-term shutdown, and the terminal has remained in warm-idle since 2015. In early 2019, however, the owners informed NMFS of their intention to bring the plant back into operation.

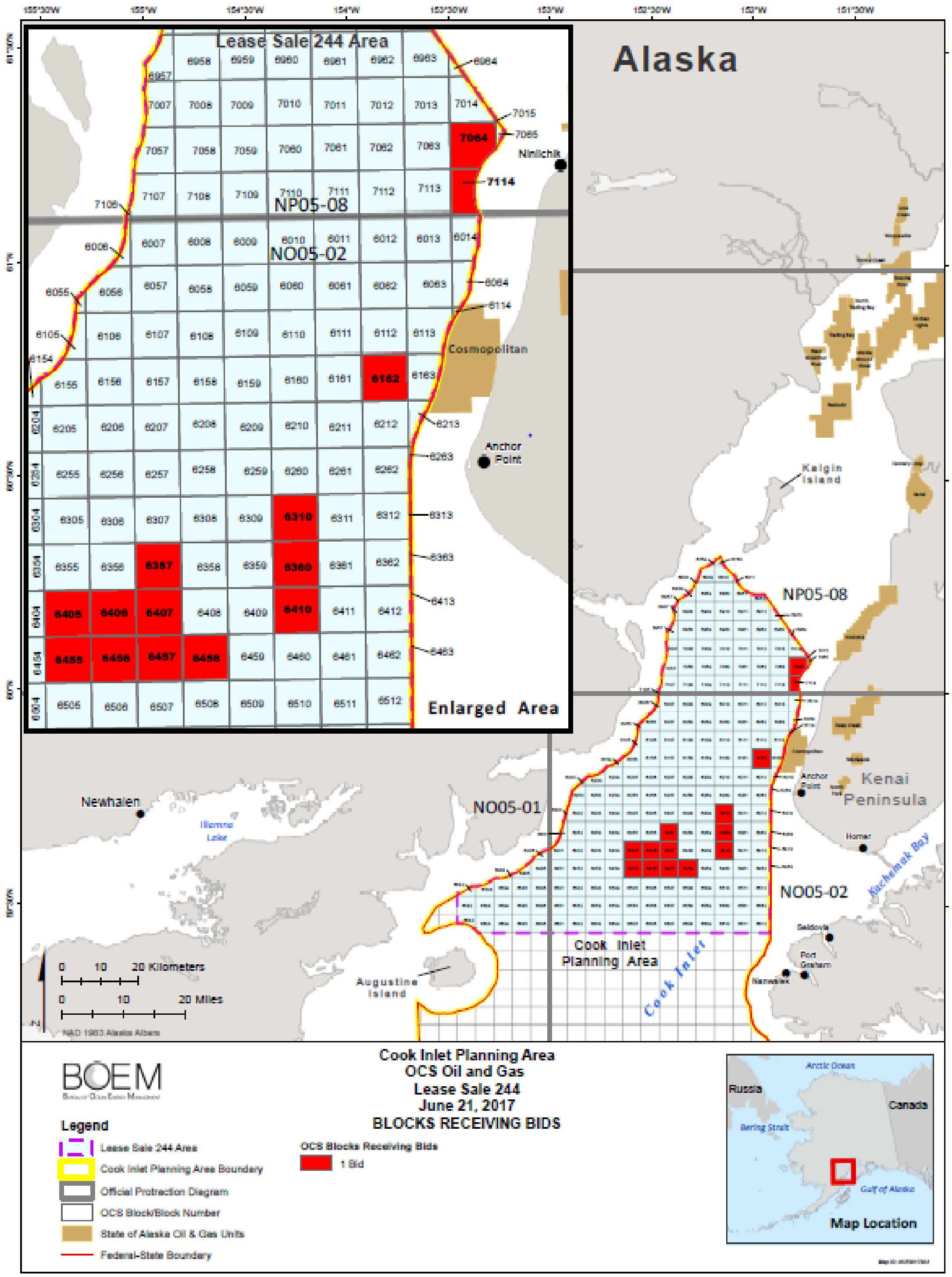

Figure 30. Lease Sale 244 blocks receiving bids. Surveys in these blocks would be covered by the ITRs that are the subject of this Biological Opinion.

5.4 Natural and Anthropogenic Noise

Because noise is a primary source of disturbance to marine mammals, and the category of disturbance most focused on in Incidental Harassment Authorizations, this Opinion considers it as a separate category of the Environmental Baseline, although it is generally attributable to other factors in the Baseline, such as coastal development or oil & gas development.

Underwater sound in Cook Inlet is categorized as physical noise, biological noise, and human-caused noise. Natural physical noise originates from wind, waves at the surface, currents, earthquakes, ice movement, tidal currents, and atmospheric noise (Richardson et al. 1995). Tidal influences in Cook Inlet are a predominant contributor of physical noise to the acoustic environment (BOEM 2016).

Biological noise includes sounds produced by marine mammals (particularly whales and dolphins, but also pinnipeds), fish (Maruska and Mensinger 2009), and invertebrates (Chitre et al. 2005). Human-caused noise includes vessel motor sounds, oil and gas operations, maintenance dredging, aircraft overflights, construction noise, and infrastructure maintenance noise. Much of upper Cook Inlet is a poor acoustic propagation environment due to shallow depths and sand and mud bottoms. In general, ambient and background noise levels within the action area in Cook Inlet are assumed to be less than 120 dB whenever conditions are calm, and exceeding 120 dB during environmental events such as high winds and peak tidal fluctuations (Blackwell and Greene 2003, Illingworth & Rodkin 2014).

5.4.1 Seismic Activity Noise in Cook Inlet

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. From 2013 to 2015 approximately 3,367 km^2 (1,300 mi^2) of 3D and 40,000 km (25,000 mi) of 2D seismic line surveys have been conducted in Cook Inlet (Figure 31). 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.

Seismic surveys use high energy, low frequency sound in short pulse durations to characterize subsurface geology (Richardson et al. 1995), often to determine the location of oil and gas reserves. Geophysical seismic activity has the potential to harass or harm marine mammals (Nowacek et al. 2015), including beluga whales.

In the past, large airgun arrays of greater than 3,000 in^3 were used for seismic exploration in Cook Inlet; these can produce source noise levels exceeding 240 dB re 1 μPa rms. However, smaller arrays are now being used in Cook Inlet because of the generally shallow water environment and the increased use of ocean-bottom cable and ocean-bottom node technology (Rigzone 2012). 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).

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 dB_{RMS} and 4 at ≥180 dB_{RMS} (Lomac-MacNair 2014). Also during Apache's 2014 operations, four 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[7].

SAE 3D Seismic Exploration (2015)
Seismic operations took place in upper Cook Inlet; they began on 15 May 2015, and continued until 27 September 2015. Eight vessels operated during the surveys including two seismic source

[7] This project occurred prior to the issuance of the new Level A guidance (NMFS 2018a), and references the old 180/190 Level A thresholds.

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.

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 through 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 through 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 et al. 2015).

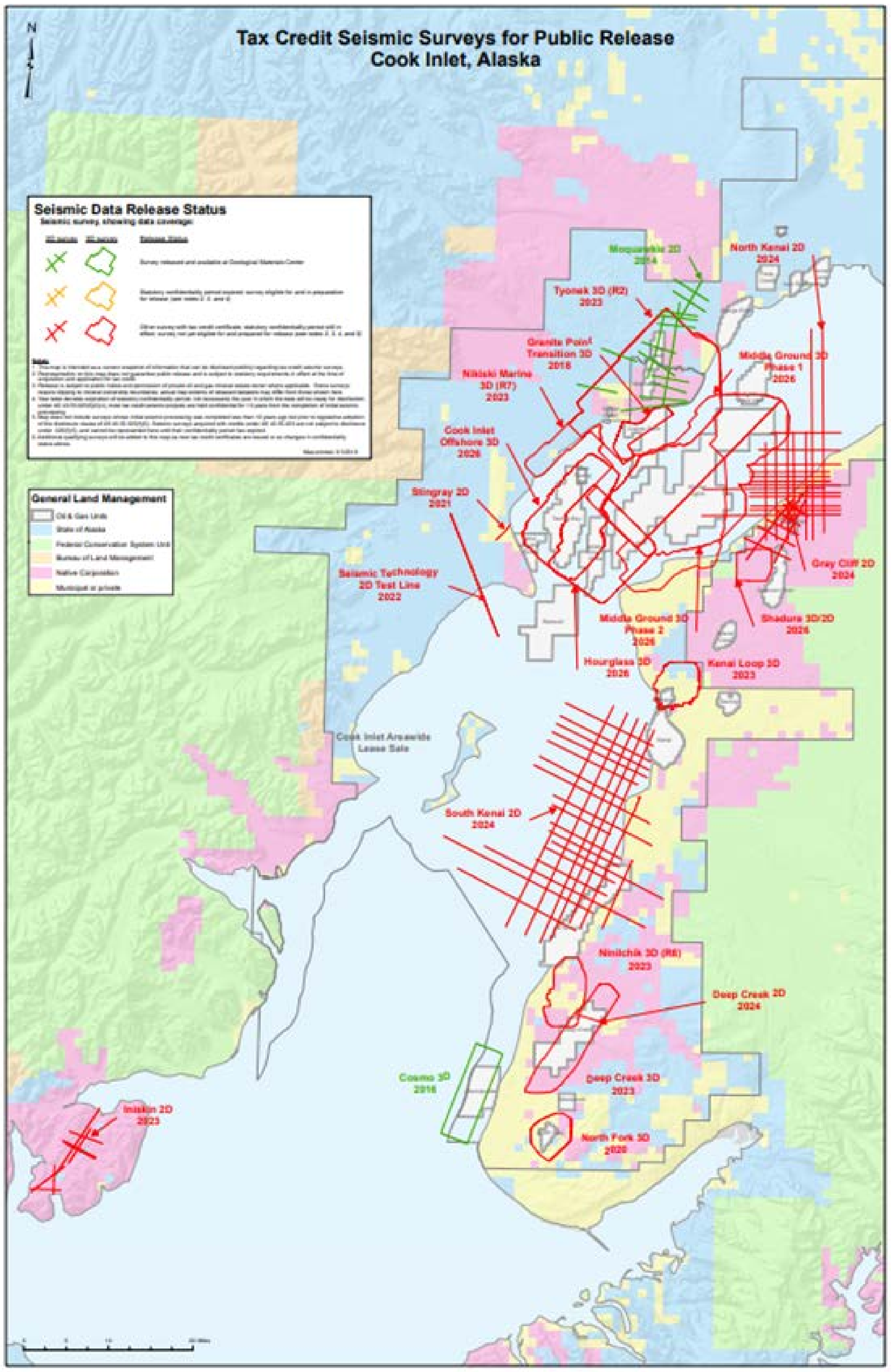

Figure 31. Seismic surveys in Cook Inlet. Dates indicate year technical data is scheduled for release. [8]

[8] http://dog.dnr.alaska.gov/Documents/Programs/CookInletTaxCreditSeismicData.pdf

5.4.2 Oil and Gas Exploration, Drilling, and Production Noise

The greatest noise levels from drilling platforms originate from operating noises from the oil platform, not from the noise generated by drilling, with frequencies 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. 1995) 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 2002). Blackwell and Greene (2002) recorded underwater noise produced at Phillips A oil platform (now the Tyonek platform) at distances ranging from 0.3 to 19 km (0.2 to 12 mi) from the source. The highest recorded sound level was 119 dB at a distance of 1.2 km (0.75 mi). 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.

<u>AK LNG (2016)</u>
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 geological and geophysical (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 greater than 700 m from the vessel outside of the harassment zone for that project activity (vessel movement). All marine mammal sightings in the SUDEX occurred during non-operational periods (i.e. when no vibracore operations were occurring; (Smultea Environmental Sciences 2016)).

<u>Furie Exploration Drilling (2017)</u>
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 2017a). No take is anticipated or authorized for 2017 operations. However, subsequent activities will require MMPA authorization.

5.4.3 Construction and Dredging Noise

Pile driving and dredging are the primary sources of construction noise in Cook Inlet. The Port of Alaska is dredged annually and is in need of extensive renovation. Corroding piles and decades of damage from Cook Inlet ice have weakened Terminal 1, where in summer 2017, a 57,000-pound fender fell off the dock while a cruise ship was in port. The renovations will entail driving many new piles to support new Port structures. The Port has recently undertaken an outreach campaign to inform the public about the great need for repairs. Port Mackenzie, located just two miles away across Cook Inlet, has also undergone recent renovations and multiple emergency repairs requiring pile driving, including removal and installation of sheet piles (NMFS 2017c).

The majority of such construction activities have taken place near Anchorage. Therefore, most of the studies documenting construction noise in Cook Inlet have occurred outside of the action area. Moreover, these studies have focused almost exclusively on pile driving because of the concerns of potential harassment to beluga whales from this activity. As a result there is very little to no documentation of noise levels from other construction activity in Cook Inlet. Only a few studies have recorded dredging noise near the POA (USACE-DOER 2001, URS 2007).

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 the time that this project took place; activities that introduced noise to the marine environment. However, there was no documentation of noise levels from this repair work.

5.4.4 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. Vessel traffic density in Cook Inlet is concentrated along the eastern margin of the Inlet between the southern end of the Kenai Peninsula and north to Anchorage (Figure 32). Oil produced on the western side of Cook Inlet is transported by tankers to the refineries on the east side. As stated earlier, the possible decommissioning of the Drift River Terminal that is part of this proposed action would eliminate one substantial source of tanker traffic in Cook Inlet.

Two of the vessels that make regular calls to the POA, the *Midnight Sun* and the *North Star*, are 53,000-horsepower, 839-foot cargo ships that pass through the action area at 15 to 20 knots four times per week, equaling 208 transits per year (Eley 2012). Blackwell and Greene (2003) observed that beluga whales “did not seem bothered” when the whales were travelling slowly within a few meters of the hull and stern of the moored cargo-freight ship *Northern Lights* in the Anchorage harbor area. They speculated that in areas where belugas are subjected to a lot of (perennial) boat traffic, they may habituate and become tolerant of the vessels. However, noises from ships and other activities in Cook Inlet area may cause a decrease or cessation of beluga vocalizations, or mask their vocalizations (Castellote et al. 2016).

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 2017).

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 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 2014, 2016a). 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.

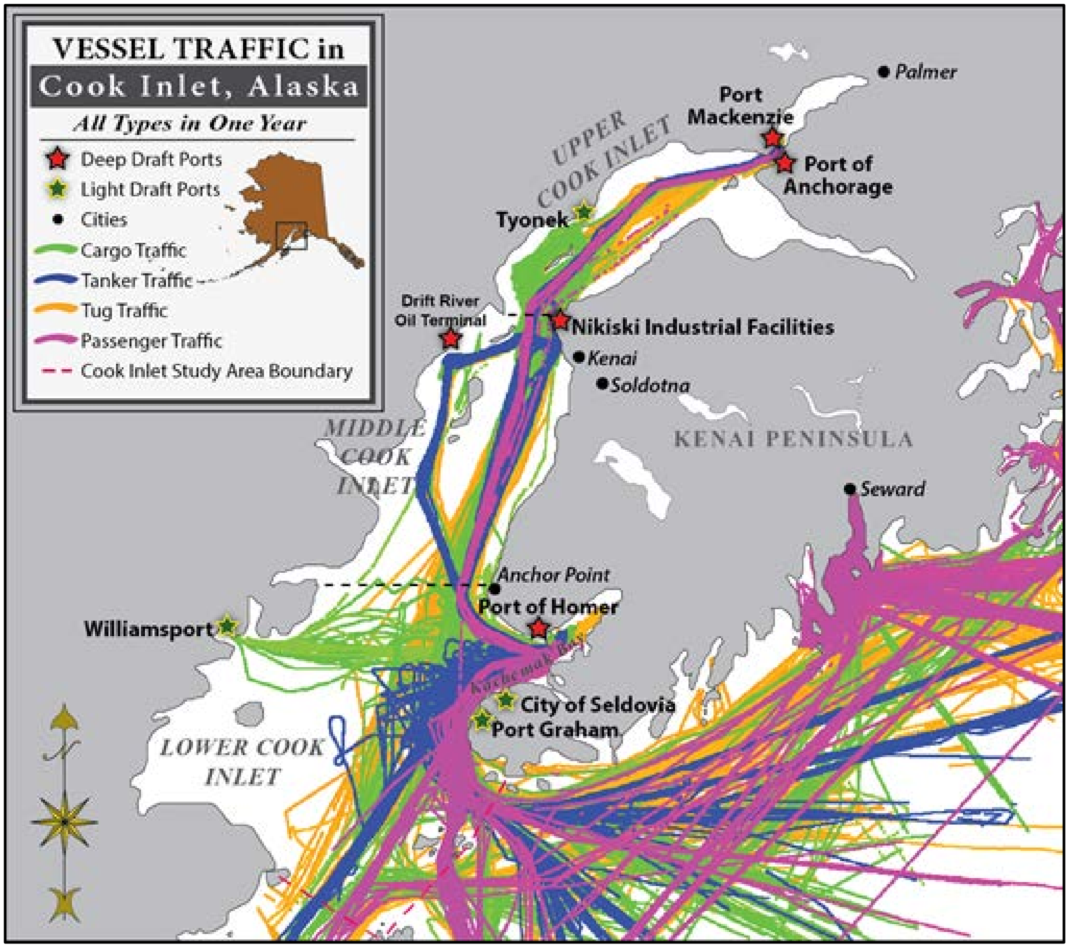

Figure 32. Summary of Cook Inlet Vessel Traffic by Vessel Type (Cape International, Inc. 2012, BOEM 2017b). Only vessels more than 300 gross tons are shown.

5.4.5 Aircraft Noise

The airspace above Cook Inlet experiences significant levels of aircraft traffic. Anchorage Ted Stevens International Airport is directly adjacent to lower Knik Arm and receives high volumes of commercial air traffic. It is also the second largest air cargo hub in the U.S. Joint Base Elmendorf Richardson also has a runway near and airspace directly over Knik Arm. Lake Hood in Anchorage is the world's largest and busiest seaplane base and the only seaplane base with primary airport status in the U.S. (Federal Aviation Administration 2016). Other small public runways are found at Birchwood, Goose Bay, Merrill Field, Girdwood, the Kenai Municipal Airport, Ninilchik, Homer, and Seldovia. Oil and gas development projects often involve helicopters and fixed-winged aircraft, and 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 within or near the 13° overhead cone and surface conditions are calm (Richardson et al. 1995).

Richardson et al. (1995) observed that beluga whales in the Beaufort Sea will dive or swim away when low-flying (500 m (1640 ft)) aircraft pass above them. Observers aboard Cook Inlet beluga whale survey aircraft flying at approximately 244 m (800 ft) report little or no change in swimming direction of the whales (Rugh et al. 2000). However, ground-based biologists note that Cook Inlet belugas often dive and remain submersed for longer than is typical when aircraft fly past at low altitudes or circle them (NMFS unpublished data). Individual responses of belugas may vary, depending on previous experiences, beluga activity at the time of the noise, and noise characteristics.

The noise and visual presence of aircraft can result in behavioral changes in whales such as diving, altering course, vigorous swimming, and breaching (Patenaude et al. 2002). Aircraft can also result in disturbance to Steller sea lions, especially if they are hauled out on land. Disturbance on a rookery or haulout could easily lead to serious injury or death, mainly due to trampling. MML scientists have reported an event where over 1,000 sea lions stampeded off a beach in response to a large helicopter over 1 mile away (Withrow 1982).

5.4.6 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 2016a).

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 (NMFS 2008c). 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 (McCauley et al. 2003, Slabbekoorn et al. 2010, Casper et al. 2012, Halvorsen et al. 2012). 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 1μPa_{rms}) 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 2008c, 2016a).

5.5 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).

Upper Cook Inlet was designated as a Category 3 on the Clean Water Act Section 303(d) list of impaired water bodies by the Alaska Department of Environmental Conservation (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 Environmental Protection Agency (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.

The Recovery Plan for the Beluga Whale (NMFS 2016a) states that exposure to industrial chemicals as well as to natural substances released into the marine environment is a potential health threat for Cook Inlet belugas and their prey. An in-depth review of available information on pollution and contaminants in Cook Inlet is presented in the Recovery Plan.

Cook Inlet beluga whales are exposed to chemical concentrations that are typically lower than those experienced by other Arctic marine mammals (Becker et al. 2000, Becker et al. 2010). 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. Sources of contamination to Cook Inlet resulting from the proposed action are from accidental releases from the marine vessels, drilling muds, effluent from platforms, and unlawful spills from wells and pipelines.

5.5.1 Petrochemical spills

Given the amount of oil and gas production and vessel traffic, spills of petroleum products are a threat to 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 1990), and oil has been implicated in the deaths of pinnipeds, including 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. Oil spills that occur in or upstream of Cook Inlet could result in marine mammals 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).

Toxic substances, such as oil, may be a contributing factor in the decline of the Western DPS Steller sea lion population (NMFS 2008c). 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.

According to the ADEC's oil spills database, oil spills in 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 Hilcorp 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 (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 (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 2016). No large spills have occurred in the area in recent years (BOEM 2017).

On February 7, 2017, a Hilcorp helicopter flying between Nikiski and Platform A identified bubbles resulting from a natural gas leak in one of their pipelines. The gas leak was reported to the National Response Center and ADEC. Subsequent Hilcorp data revealed that the leak had been occurring since late December. The initial estimated leak rate was between 225,000 to 325,000 cubic feet per day from an eight-inch pipeline 80 feet below Cook Inlet waters (Hilcorp 2017b). The cause of the release was a large rock that caused a breach in the line.

Hilcorp worked closely with NMFS, the Pipeline and Hazardous Materials Safety Administration (PHMSA), ADEC, and other stakeholders to conduct mitigation and monitoring actions during the gas release and subsequent repair. Initially, Hilcorp significantly reduced gas flow through the line, but did not shut down the line completely for fear of residual oil leaking into the marine environment. Divers installed a temporary pipeline clamp on April 13, 2017, but due to weather and ice conditions, a permanent repair was not completed until May 19, 2017. Limited aerial surveys of wildlife in the vicinity of the leak did not indicate the presence of any marine mammals near the leak (Hilcorp unpublished data).

On April 1, 2017, an oil spill was detected off the Anna Platform in Cook Inlet. Hilcorp reported the incident to ADEC on the same day. Documentation from Hilcorp indicates the release resulted from an accident on the Anna Platform production facility flare system. It was estimated a maximum of three gallons of oil was discharged into the marine environment.

Subsequent to these accidents, Hilcorp has updated their Integrity Management Plan. Current pipeline operation and maintenance mitigation measures are described in Section 2.1.2 of this Opinion.

The Anna Platform experienced a diesel beam tank spill of 441 gallons on January 24, 2018. All the diesel was recovered and recycled. Hilcorp has also reported recent minor spills ($\leq$ 200 gallons) of drilling mud from the Steelhead and Granite Platforms and a glycol spill from the Bruce Platform, with most or all spilled material recovered[9].

The ADEC Statewide Oil Spills Database[9] has records of three spills in Cook Inlet in 2019, a release of 0.1 lb of natural gas from Hilcorp Platform A in Trading Bay on April 27, 2019 which naturally dispersed, a 42gal spill of crude oil from the Drift River Terminal also on April 27, 2019 for which the disposal method was not reported, and an onshore spill of 210gal of crude oil at the Hilcorp MGS Onshore Facility in Nikiski on April 15, 2019. The disposal method for the onshore spill was not reported, but it appears to have been contained to land and did not enter the marine environment. A fourth incident was reported to ADEC on May 1, 2019 consisting of a multi-day gas leak of unknown quantity at Hilcorp's Platform A.

5.5.2 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 50 to 70 percent of the solid particulate from the wastewater prior to discharge (Sonune and Ghate 2004). 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 (Sonune and Ghate 2004).

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

[9] http://dec.alaska.gov/Applications/SPAR/PublicMVC/PERP/SpillSearch

discharge[10]. 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[10]. 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 began upgrades to the facility in 2018, and will continue upgrades in 2019 and 2020[11].

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 (NMFS 2008a, EPA 2015). 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 2015).

5.5.3 Mixing Zones

In 2010, EPA consulted with NMFS on the approval of ADEC's 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 2010). 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 2018, EPA and NMFS began formal consultation on the effects of EPA approval of the Mixing Zone Regulation following designation of Cook Inlet beluga whale critical habitat. That

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[10] https://www.awwu.biz/home/showdocument?id=1466

[11] https://www.kenai.city/sites/default/files/fileattachments/finance/page/5221/draft_budget_050119.pdf

consultation is on-going.

5.5.4 Stormwater Runoff

Stormwater pollutants may include street and aircraft deicer, oil, pesticides and fertilizers, heavy metals, and fecal coliform bacteria. Public Works (WMS) and the Alaska Department of Transportation and Public Facilities (ADOT&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 POA, 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.

5.5.5 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 (TSAIA) 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).

5.5.6 Ballast Water Discharges

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 on 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.

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, ADFG 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/

5.5.7 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).

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

5.6 Fisheries

Cook Inlet supports 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 2017). Portions of central and southern Cook Inlet district management areas are within the proposed 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 2017, 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).

Recreational fisheries exist in the river systems on the western Kenai Peninsula for salmon (king, silver, red, and pink), both freshwater and marine Dolly Varden char, and both freshwater rainbow trout and steelhead trout. In the marine waters throughout Cook Inlet, recreational fishing occurs for salmon (king and silver) and halibut. Many of the charter fishing vessels targeting salmon and halibut operate out of Homer, in lower Cook Inlet.

ADF&G will continue to manage fish stocks and monitor and regulate fishing in Cook Inlet to maintain sustainable stocks. An important remaining unknown is the extent to which Cook Inlet marine mammal prey is made less available due to commercial, subsistence, personal use, and sport fishing either by direct removal of the prey or by human-caused habitat avoidance. Gathering data on this threat near the mouths of salmon and eulachon spawning streams is especially important.

Potential impacts from commercial fishing on Cook Inlet beluga, fin, and humpback whales, and Steller sea lions include ship strikes, harassment, gear entanglement, reduction of prey, and displacement from important habitat. For example, the Kenai River is the most heavily-fished river in Alaska[12], while also important foraging habitat for Cook Inlet beluga whales (e.g., waters within and near the outlets of the Kenai and Kasilof Rivers during salmon season) (Castellote et al. 2016; Figure 13).

5.6.1 Entanglement

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 belugas becoming

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[12] http://www.adfg.alaska.gov/index.cfm?adfg=ByAreaSouthcentralUpperKenai.fishingInfo

entangled in fishing nets, the only known mortality associated with entanglement in a fishing net was from a young Cook Inlet 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 Cook Inlet belugas. For example, in 2005, a Cook Inlet 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 Cook Inlet 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 2016a).

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. 2018).

Humpback whales can be killed or injured during interactions with commercial fishing gear, although the evidence available suggests that the frequency of these interactions may not have significant, adverse consequence for humpback whale populations. Most humpbacks get entangled with gear between the beginning of June and the beginning of September, when they are on their nearshore foraging grounds in Alaska waters. Between 1990 and 2016, 29 percent of humpback entanglements were with pot gear and 37 percent with gillnet gear. Longline gear comprised only 1-2 percent of all humpback fishing gear interactions.

A photographic 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. 2018). There are no known occurrences of fishery-related take of humpback whales in the action area.

Overall, the estimated mean annual mortality and serious injury rate from U.S. commercial fisheries is 31 sea lions per year, which is likely an underestimate of the actual level (Muto et al. 2018). Of these, 16 are taken in federally managed commercial fisheries. 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 2008c). 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).

5.6.2 Competition for Prey

Fisheries in Cook Inlet have varying likelihoods of competing with marine mammals for fish depending on gear type, species fished, timing, and fisheries location and intensity. For Cook Inlet beluga whales, there is a substantial likelihood of reduced prey availability and/or habitat displacement due to commercial fishing activity. The operation of watercraft near the mouths and deltas of rivers entering Cook Inlet, Turnagain Arm, and Knik Arm can affect beluga whales, hindering them from using these waters in pursuit of eulachon and salmon prey. For example, while NMFS has numerous reports of beluga whales in the Kenai River prior to and after the summer salmon fishing season, they have not been observed in or near the river in recent times when salmon runs are strong and fishing activity (commercial, recreational, and personal use) is high (Shelden et al. 2015b, Castellote et al. 2016).

There is strong indication that Cook Inlet beluga whales are dependent on access to relatively dense concentrations of high value prey species, particularly in the spring and throughout the summer months. (Norman 2011) estimated that the total biomass of fish consumed by 350 Cook Inlet beluga whales during the summer would be approximately 1250 metric tons. Chum, coho, and other salmonid species constitute >54 percent of the Cook Inlet beluga whales' summer diet (Hobbs and Shelden 2008). In 2016, approximately 3.0 million salmon were harvested commercially in upper Cook Inlet, which is below the average annual harvest of 3.5 million from 1966-2016. Approximately 95.8 tons of smelt (100 tons is the maximum allowable harvest), 22.9 tons of herring, and 285,000 pounds of razor clams were commercially harvested from upper Cook Inlet in 2016 (Shields and Dupuis 2017). A significant reduction in the amount of available prey could impact the energetics for Cook Inlet beluga whales and delay recovery.

Whether fisheries reduce Steller sea lion prey biomass and quality at local and/or regional spatial scales, leading to a reduction in Steller sea lion survival and reproduction, has been a matter of considerable debate among the scientific community (NMFS 2008c). The most recent minimum total annual mortality of Western DPS Steller sea lions associated with commercial fisheries is 31 individuals (Muto et al. 2018).

There is no known information summarizing interactions between fishing in Cook Inlet and large cetaceans. Prey competition is unlikely to occur, as the important foraging areas for humpback and fin whales are outside of Cook Inlet.

5.7 Tourism

Tourism continues to grow on the Kenai Peninsula, with two popular destinations being Homer and Kenai on the western Peninsula (and mid to lower Inlet). While fishing in the Kenai River is a major draw in the city of Kenai, a number of commercial vessel-based tour companies operate in the marine waters of lower Cook Inlet, primarily out of Homer. These tour vessels range from small, six-passenger vessels to larger vessels that carry 100 or more passengers. These tours including fishing options, however wildlife viewing (including marine mammal watching) is also a popular tour.

In addition to vessel and land-based tourism, there are a number of commercial operators for flight-seeing tours out of Homer. These operators offer tours for glacier and wildlife viewing, including whales, bears, mountain goats and moose. These flights occur over land on the Kenai Peninsula, the waters of lower Cook Inlet (Kachemak Bay), and across the Inlet to the places such as Katmai National Park and McNeil River State Game refuge. While flying along the coast or over marine waters, these planes have the potential to disturb marine mammals, including whales, but particularly also pinnipeds on haulouts and rookeries, such as sea lions.

There are no commercial whale-watching companies operating 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. Vessel-based whale-watching, should it occur, would likely stress the beluga population by increasing intrusion into beluga habitat not ordinarily accessed by many boats. 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 to approach the beluga whales more closely than recommended for marine mammals. 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, and currents). We are aware that some aircraft have circled around groups of Cook Inlet beluga whales, disrupting their diving and possibly feeding activities (NMFS, unpublished data). NMFS has undertaken outreach efforts to educate local pilots of the potential consequences of such actions, providing guidelines encouraging pilots to maintain altitudes of 1500 feet over belugas and not to circle over them.

5.8 Direct Mortality

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

5.8.1 Subsistence Harvest

The ESA and MMPA allow for the harvest of marine mammals by Alaska Natives for subsistence purposes and for traditional handicrafts. 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 (Muto et al. 2018). 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 illegally harvested in the Kuskokwim River in July, 2017. Low levels of unreported gray and minke whale subsistence harvest likely occur elsewhere in remote rural Alaska.

Annual statewide data on community subsistence harvest of Steller sea lions are no longer collected as of 2009. The mean annual subsistence take (harvested plus struck-and-lost) from the Western DPS from 2004 through 2008, combined with the mean take over the 2011-2015 period from St. Paul and St. George, is 204 sea lions per year (Muto et al. 2018). Subsistence harvest of Western DPS Steller sea lions occurs under co-management agreements with NMFS, and occurs at or well below sustainable levels of harvest.

The effect from past subsistence harvests on the Cook Inlet beluga whale population was significant (Figure 11). While an unknown amount of harvest occurred for decades or longer, the subsistence harvest levels increased substantially in the 1980s and 1990s to unsustainable levels. 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 that spring, and Public Law 106-553 section 627, which required hunting of Cook Inlet beluga whale for subsistence uses be conducted pursuant to a cooperative agreement between NMFS and affected Alaska Native organizations. In 2005, the co-management agreement allowed the harvest of two whales. In 2006, the co-management agreement allowed the harvest of one whale, however no whales were taken due to poor weather, and hunter's avoidance of females with calves.

In 2008, NMFS issued regulations (73 FR 60976) establishing long-term limits on the maximum number of Cook Inlet beluga whales that may be taken for subsistence by Alaska Natives. These long-term harvest limits, developed for five-year intervals, require that the abundance estimates reach a minimum five-year average of 350 belugas (50 CFR 216.23(f)(2)(v)). There has not be an allowed hunt since 2006.

5.8.2 Poaching and Illegal 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. Although NMFS maintains an enforcement presence in upper Cook Inlet, effective enforcement across such a large area is difficult. No poaching incidents have been confirmed to date, although NMFS Enforcement has investigated several reported incidences of Cook Inlet beluga whale harassment.

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 (Wright and Savage 2016).

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

5.8.3 Stranding

Live stranding occurs when a marine mammal is found in waters too shallow to swim. Cook Inlet beluga whales are probably predisposed to stranding because they breed, feed, and molt in the shallow waters of upper Cook Inlet where extreme tidal fluctuations occur. However, stranding events that last more than a few hours may result in mortalities. Strandings can be intentional (e.g., to avoid killer whale predation), accidental (e.g., chasing prey into shallows then becoming trapped by receding tide), or a result of injury, illness, or death.

An estimated 876-953 live beluga strandings and a total of 214 dead beluga beachings have been documented in Cook Inlet from 1988 through 2015 (NMFS 2016a). Beluga whale stranding events may represent a significant threat to the conservation and recovery of this stock.

In nearly all known cases, strandings of humpback and fin whales represent animals that died at sea of various other causes and washed ashore; a young humpback whale live stranded on mud in Turnagain Arm in April 2019, and while it freed itself on an incoming tide at one point, the animal later died.

Live strandings do not often occur among sea lions, which have mobility out of water, although pinniped strandings and mortality resulting from entanglement in fishing gear have been documented (Loughlin and York 2000, Raum-Suryan et al. 2009, Muto et al. 2018).

5.8.4 Predation

Killer whales are the only natural predators for beluga whales and Steller sea lions in Cook Inlet (Muto et al. 2018). 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). Killer whale sightings were not well-documented and were likely rare in the upper inlet prior to the mid-1980s. From 1982 through 2014, 29 killer whale sightings in upper Cook Inlet (north of the East and West Forelands) were reported to NMFS. It is not known which of these were mammal-eating killer whales (i.e., transient killer whales) that might prey on beluga whales or fish-eating killer whales (i.e., resident killer whales) that would not prey on beluga whales.

Between 9 and 12 beluga whale deaths during this time (1982-2014) were suspected to be a direct result of killer whale predation (NMFS 2016a). From 2011 through 2014, NMFS received no reports of killer whale sightings in upper Cook Inlet or possible predation attempts. Prior to 2000, an average of one Cook Inlet beluga whale was killed annually by killer whales (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 the remains of preyed-upon belugas may sink and go undetected by humans. 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 to Western DPS Steller sea lions from killer whale predation is considered potentially high (Muto et al. 2018), and may be one of the causes contributing to past steep declines in population.

5.8.5 Vessel Strikes

Cook Inlet beluga whales may be susceptible to vessel strike mortality. To date, however, only one whale death, in October 2007, has been attributed to a potential vessel strike based on bruising consistent with blunt force injuries (NMFS unpublished data). Beluga whales may be especially susceptible to strikes from commercial and recreational fishing vessels (as opposed to cargo ships, oil tankers and barges) since both belugas and fishing activities occur where salmon and eulachon congregate. A number of beluga whales have been photographed with propeller scars (McGuire et al. 2014), suggesting that small vessel strikes are 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.

Although risk of vessel strike has not been identified as a significant concern for Steller sea lions, 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 2008c). In 2007, a Steller sea lion was found in Kachemak Bay that may have been apart of a boat collision. The Steller sea lion had two separate wounds consistent with blunt trama (NMFS Alaska Regional Office Stranding Database accessed May 2019).

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 percent of all reported collisions. There have been five documented large cetacean vessel collisions in Cook Inlet since 2001; one humpback whale, one fin whale, two beluga whale, and one unidentified large cetacean. In 2001, a humpback whale was discovered on the bulbous bow of a 710 ft container ship as it docked in the Port of Anchorage. It is unknown where the vessel may have collided with the whale. In 2002, a beluga whale was seen with 3 to 4 propeller slashes, it is unknown the actual cause of death. In 2005, a 28 ft charter boat hit an unidentified large cetacean (NMFS Alaska Regional Office Stranding Database accessed May 2019). 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). In 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 strike occurred (NMFS Alaska Regional Office Stranding Database accessed May 2019).

5.8.6 Research

Research is a necessary endeavor to assist in the recovery of threatened and endangered species; however, research activities can also disturb these animals. Research on marine mammals often require boats, adding to the vessel traffic, noise, and pollution near the action area. Aerial surveys could also disturb whales, especially when circling at low-altitudes to obtain accurate group counts occurs. Boat based surveys, such as photo-identification studies, 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, passive acoustic monitoring is noninvasive.

Research activities can be more invasive, especially when they include animal capture, collecting blood and tissue samples, or attaching tracking devices such as satellite tags. In the worst case, research can result in deaths of the animals. 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 is unknown whether these whales, tagged in the same manner as the one that died, also perished, or were fitted with defective tags (NMFS, unpublished data). In 2015, an additional animal previously tagged by researchers washed up dead, with infection at the site of instrument attachment implicated as a possible cause of death.

Although research may affect beluga whales, it is anticipated that research will continue to increase because there are many remaining data gaps on Cook Inlet beluga whale biology and ecology (NMFS 2016a). However, managers are cautious in permitting only minimally invasive research techniques.

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.

5.9 Climate and Environmental Change

Since the 1950s the atmosphere and oceans have warmed, snow and sea ice have diminished, sea levels have risen, and concentrations of greenhouse gases have increased (IPCC 2014). There is little doubt that human influence has been the dominant cause of the observed warming since the mid-20th century (IPCC 2014). The impacts of climate change are especially pronounced at high latitudes and in polar regions. Average temperatures have increased across Alaska at more than twice the rate of the rest of the United States (EPA 2017). In the past 60 years, average air temperatures across Alaska have increased by approximately 3°F, and winter temperatures have increased by 6°F (Chapin et al. 2014). Some of the most pronounced effects of climate change in Alaska include disappearing sea ice, shrinking glaciers, thawing permafrost, and changing ocean temperatures and chemistry (Chapin et al. 2014). Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (Houghton 2001, McCarthy et al. 2001).

The impacts of these changes and their interactions on listed species in Alaska are hard to predict. A recent period of especially warm water in the North Pacific Ocean, referred to as “the blob,” is likely responsible for poor growth and survival of Pacific cod, an important prey species for endangered Steller sea lions. The 2018 Pacific cod stock assessment estimated that the female spawning biomass of Pacific cod is at its lowest point in the 41-year time series considered in the assessment. This assessment was conducted following three years of poor recruitment in 2014-2016 and increased natural mortality during the 2014-2016 Gulf of Alaska marine heat wave (NMFS 2018b). Biologists also attribute increases in bird die-offs, whale strandings, toxic algae blooms, and poor salmon survival to warmer water conditions (Bernton 2017).

The world’s oceans have absorbed approximately one-third of the anthropogenic CO_2 released, which has curtailed the increase in atmospheric CO_2 concentrations (Sabine et al. 2004). Despite the oceans’ role as large carbon sinks, in 2016, the mean monthly average CO_2 level exceeded 400 ppm and continues to rise (NOAA 2018). As the oceans absorb more CO_2, ocean acidification is occurring, which reduces the amount of calcium carbonate minerals that many organisms use to form and maintain shells (Reisdorph and Mathis 2014). Shelled zooplankton such as pteropods are prey for many species of carnivorous zooplankton, fishes including salmon, mackerel, herring, and cod, and baleen whales (Orr et al. 2005). Under increasingly acidic conditions, pteropods may not be able to grow and maintain shells, and are often considered an indicator species for ecosystem health. It is uncertain if they may be able to evolve quickly enough to adapt to changing ocean conditions (Fabry et al. 2009). Marine mammals in the Gulf of Alaska were likely impacted by the low prey availability associated with warm ocean temperatures that occurred in the Gulf during 2014-2016 (Bond et al. 2015, Peterson et al. 2016, Sweeney et al. 2018).

Additionally, as the ocean becomes more acidic, low frequency sounds (1 to 3 kHz and below) travel farther because the concentrations of certain ions that absorb acoustic waves decrease with decreasing pH (Brewer and Hester 2009).

The physical environment of Cook Inlet is shifting, with a reduction in duration of seasonal sea ice. In Cook Inlet, mesozooplankton biomass increased each year from 2004 to 2006; however, sampling from late 2006 to early 2007 suggests biomass values are decreasing (Batten and Mackas 2007), a change the authors suggest was driven by changes in climate. Changes in temperature affect zooplankton abundance, which in turn may influence fish species composition, and hence, the quality and types of fish available for marine mammals.

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 2016 (Figure 20). 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 development and production associated with this proposed action. However, we note that any production of oil and gas 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 Alaskan waters in 2015-2016. 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 habitat 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 2010a, 2016a). 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 (Hollowed and Wooster 1992, Anderson and Piatt 1999, Hare and Mantua 2000) 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.

5.10 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 2016a)).

5.11 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 27), particularly at the Port of Anchorage, has resulted in exposure of beluga whales to noise levels capable of causing harassment.
- Oil and gas development (Figure 28) has resulted in 79 spills releasing 126,259 gallons of oil into Cook Inlet since 1962.
- Seismic exploration has introduced sounds exceeding 240 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 27), likely competing with the whales for their prey. 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.
- 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.
- Subsistence harvest of Western DPS Steller sea lions occurs under co-management agreements with NMFS, and occurs at or well below sustainable levels of harvest.
- Vessel traffic in Cook Inlet (Figure 32) 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. Strikes have involved cruise ships, recreational cruisers, whale watching catamarans, fishing vessels, and skiffs. 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 magnitude of effects of Arctic climate change on ice-associated marine mammals. 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 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 12).

Populations of fin whales, Western North Pacific DPS and Mexico DPS humpback whales, and Western DPS 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*,[13] 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.

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 is 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). In analyzing the effects of the proposed action, we assume the maximum amount of possible proposed activities will occur.

We organize our effects analysis using a stressor identification – exposure – response – risk assessment framework for the proposed activities.

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

[13] 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.

action poses to endangered and threatened species.

6.1 Project Stressors

Stressors are any physical, chemical or biological entity that can induce an adverse response. The effect 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 Hilcorp Cook Inlet oil and gas activities may result in the following stressors (direct effects) to ESA-listed marine mammals and critical habitat for beluga whales and Steller sea lions:

1. Sound field produced by impulsive noise sources such as: 2D/3D seismic surveys, geohazard surveys, pipe driving, VSP, and pingers;
2. Sound fields produced by non-impulsive noise sources such as: drilling operations, well plugging and abandonment, water jets and hydraulic grinders, vibratory sheet pile driving, rock laying, tugs towing, other support vessels, and aircraft (fixed-wing, helicopter, and drones);
3. Risk of vessels striking marine mammals;
4. Seafloor disturbance and habitat alteration from drilling activities, placement of equipment or anchors, and construction of Iniskin Peninsula causeway;
5. Entanglement and ingestion of trash and debris; and
6. Pollution from unauthorized spills.[14]

Below we discuss each stressor's potential to affect ESA-listed species and critical habitat for beluga whales and Steller sea lions.

All potential stressors from the proposed action were considered, individually and cumulatively, in developing the analysis and conclusions in this opinion regarding the effects of the proposed action on ESA-listed species (Cook Inlet beluga whales, humpback whales, fin whales and Steller sea lions) and critical habitat for beluga whales and Steller sea lions.

[14] Although we are not consulting on oil spills and they are not a direct effect of the action, we consider their possibility in association with the proposed action and try to assess the probability of their occurrence and potential risk to listed marine mammals.

6.2 Exposure and Response 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.

As discussed in Section 2.1.2 above, the NMFS Permits Division proposed mitigation measures should avoid or minimize exposure of Cook Inlet beluga whales, humpback whales, fin whales, and Steller sea lions to stressors. Refer to Section 2.1.2 for details on the proposed mitigation measures.

For our exposure analyses, NMFS generally considers an action agency's estimates of the number of marine mammals that might be "taken" over the duration of the proposed action. Hilcorp provided a five-year quantitative exposure analysis to NMFS Permits Division with its ITR application. Based on these initial qualitative and quantitative analyses, NMFS Permits Division calculated the exposure and "take" estimates for the five years of the project.

Following the exposure analysis is the response analysis. The 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.

Possible responses by ESA-listed marine mammals to project activities in this analysis are:

- Threshold shifts
- Auditory interference (masking)
- Behavioral responses
- Non-auditory physical or physiological effects

Responses from ESA-listed species to project activities are discussed for each stressor.

Threshold Shift

Exposure of marine mammals to very loud noise can result in physical effects, such as changes to sensory hairs in the auditory system, which may temporarily or permanently impair hearing. Temporary threshold shift (TTS) is a temporary hearing change, and its severity is dependent upon the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt 2013). TTSs can last minutes to days. Full recovery is expected, and this condition is not considered a physical injury. At higher received levels, or in frequency ranges where animals are more sensitive, permanent threshold shift (PTS) can occur. When PTS occurs, auditory sensitivity is unrecoverable (i.e., permanent hearing loss). The effect of noise exposure generally depends on a number of factors relating to the physical and spectral characteristics of the sound (e.g., the intensity, peak pressure, frequency, duration, duty cycle), and relating to the animal under consideration (e.g., hearing sensitivity, age, gender, behavioral status, prior exposures). Both TTS and PTS can result from a single pulse or from accumulated effects of multiple pulses from an impulsive sound source (i.e., impact pile or pipe driving) or from accumulated effects of non-pulsed sound from a continuous sound source (i.e., vibratory pile driving). In the case of exposure to multiple pulses, each pulse need not be as loud as a single pulse to have the same accumulated effect.

As it is a permanent auditory injury, the onset of PTS may be considered an example of “Level A harassment” as defined in the MMPA. TTS is by definition recoverable rather than permanent, and has historically has been treated as “Level B harassment” under the MMPA. Behavioral effects may also constitute Level B harassment, and are expected to occur at even lower noise levels than would generate TTS.

Masking

The concept of acoustic interference is familiar to anyone who has tried to have a conversation in a noisy restaurant or at a rock concert. In such situations, the collective noise from many sources can interfere with one’s ability to understand, recognize, or even detect sounds of interest. Masking from anthropogenic noise sources may disrupt marine mammal communication when sound frequencies overlap communication frequencies used by marine mammals. Studies have shown that cetaceans’ response may be similar to that of humans speaking louder to communicate in a noisy situation. Holt et al. (2009) found that Southern Resident killer whales in Puget Sound near Seattle increased their call amplitude by 1 dB for every 1 dB increase in background noise levels.

Critical ratios, a measure of the relative ability of an animal to extract signals from noise, have been determined for pinnipeds (Southall et al. 2000, 2003) and bottlenose dolphins (Johnson 1967). These studies provide baseline information from which the probability of masking can be estimated.

Clark et al. (2009) developed a methodology for estimating masking effects on communication signals for low frequency cetaceans, including calculating the cumulative impact of multiple noise sources. For example, their technique calculates that in Stellwagen Bank National Marine Sanctuary, when two commercial vessels pass through a North Atlantic right whale’s optimal communication space (estimated as a sphere of water with a diameter of 20 km), that space is decreased by 84 percent. This methodology relies on empirical data on source levels of calls (which is unknown for many species), and requires many assumptions about ambient noise conditions and simplifications of animal behavior. However, it is an important step in determining the impact of anthropogenic noise on animal communication. Subsequent research for the same species and location estimated that an average of 63 to 67 percent of North Atlantic right whale’s communication space has been reduced by an increase in ambient noise levels, and that noise associated with transiting vessels is a major contributor to the increase in ambient noise (Hatch et al. 2012).

Vocal changes in response to anthropogenic noise can occur across sounds produced by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes to vocal behavior and call structure may result from a need to compensate for an increase in background noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying. Vocalizations may also change in response to variation in the natural acoustic environment (e.g., from variation in sea surface motion; (Dunlop et al. 2014)).

Hilcorp Alaska's oil and gas activities in Cook Inlet are not expected to result in extended periods of time where masking could occur. As stated above, masking only exists for the duration of time that the masking sound is emitted.

Behavior Response

NMFS expects the majority of ESA-listed species responses to the proposed activities will occur in the form of behavioral response. Marine mammals may exhibit a variety of behavioral changes in response to underwater sound and the general presence of project activities and equipment, which can be generally summarized as:

- Modifying or stopping vocalizations
- Changing from one behavioral state to another
- Movement out of feeding, breeding, or migratory areas

The response of a marine mammal to an anthropogenic sound will depend on the frequency, duration, temporal pattern, and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). The distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al. 2003). For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson et al. (1995). More recent reviews (e.g., Nowacek et al. 2007, Southall et al. 2007b, Southall et al. 2009, Ellison et al. 2012) focus on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated.

Except for some vocalization changes that may be compensating for auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response; however, stress responses cannot be predicted directly due to a lack of scientific data (see following section). Responses can overlap; for example, an increased respiration rate is likely to be coupled with a flight response. Differential responses are expected among and within species since hearing ranges vary across species and individuals, the behavioral ecology of individual species is unlikely to completely overlap, and individuals of the same species may react differently to the same, or similar, stressor.

Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012). This is reflected in a variety of aquatic, aerial, and terrestrial animal responses to anthropogenic noise that may ultimately have fitness consequences (Francis and Barber 2013).

Non-Auditory Physical or Physiological Effects

Individuals exposed to noise can experience stress and distress, where stress is an adaptive response that does not normally place an animal at risk, and distress is a stress response resulting in a biological consequence to the individual. Both stress and distress can affect survival and productivity (Curry and Edwards 1998, Cowan and Curry 2002, Herráez et al. 2007, Cowan and Curry 2008). Mammalian stress levels can vary by age, sex, season, and health status (St. Aubin et al. 1996, Gardiner and Hall 1997, Hunt et al. 2006, Romero et al. 2008).

Anthropogenic activities have the potential to provide additional stressors above and beyond those that occur naturally. For example, various efforts have investigated the impact of vessels on marine mammals (both whale-watching and general vessel traffic noise) and demonstrated that impacts do occur (Erbe 2002, Williams et al. 2002, Williams and Ashe 2006, Williams and Noren 2009, Pirotta et al. 2015). In an analysis of energy costs to killer whales, Williams and Noren (2009) suggested that whale-watching in the Johnstone Strait resulted in lost feeding opportunities due to vessel disturbance. During the time following September 11, 2001, shipping traffic and associated ocean noise decreased along the northeastern U.S. This decrease in ocean noise was associated with a significant decline in fecal stress hormones in North Atlantic right whales, suggesting that chronic exposure to increased noise levels, although not acutely injurious, can produce stress (Rolland et al. 2012). These levels returned to their previous level within 24 hrs after the resumption of shipping traffic. Exposure to loud noise can also adversely affect reproductive and metabolic physiology (Kight and Swaddle 2011). In a variety of factors, including behavioral and physiological responses, females appear to be more sensitive or respond more strongly than males (Kight and Swaddle 2011).

If a sound is detected by a marine mammal, a stress response (e.g., startle or annoyance) or a cueing response (based on a past stressful experience) can occur. Although preliminary because of the small numbers of samples collected, different types of sounds have been shown to produce variable stress responses in marine mammals. Belugas demonstrated no catecholamine (hormones released in situations of stress) response to the playback of oil drilling sounds (Thomas et al. 1990) but showed an increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano et al. 2004).

Whales and Steller sea lions use hearing as a primary way to gather information about their environment and for communication; therefore, we assume that limiting these abilities is stressful. Stress responses may also occur at levels lower than those required for TTS (Southall et al. 2007b). Therefore, exposure to levels sufficient to trigger onset of PTS or TTS are expected to be accompanied by physiological stress responses (NRC 2003).

We expect individuals may experience both Level A and Level B acoustic harassment, may experience masking, and may exhibit behavioral responses from project activities. Therefore, we expect ESA-listed whales and sea lions may experience stress responses. If whales and sea lions are not displaced and remain in a stressful environment (i.e., within the behavioral harassment zone), we expect the stress response will dissipate shortly after the individual leaves the area or after the cessation of the acoustic stressor.

6.2.1 Acoustic Sources Likely to Adversely Affect Listed Species or Critical Habitat

Hilcorp Alaska intends to conduct oil and gas activities that would introduce acoustic disturbance in the action area (Section 2.2). The anticipated major acoustic stressors that were used to estimate Level A or B acoustic harassment are described below including seismic surveys (i.e., 2D and 3D), geohazard and geotechnical surveys using sub-bottom profilers, vertical seismic profiling, pipe driving, vibratory sheet pile driving, and water jets. Exposure estimates and marine mammal responses to the major acoustic stressors are also described below. Section 6.2.2 describes other sound sources that may affect ESA-listed species, but were not used to estimate Level A and B acoustic harassment.

6.2.1.1 Noise Activity Description

Table 13 lists acoustic stressors and their sound source levels that may result in Level A and B acoustic harassment from Hilcorp Alaska's oil and gas activities in Cook Inlet. Sound source levels (measured or modeled) for each noise source were determined based on a literature review of the best available science.

Table 13. Summary of noise sources for each activity that is anticipated to cause Level A and B acoustic harassment.

Activity	Sound Pressure Levels (dB re 1 µPa)	Frequency	Reference
2D seismic survey (2400 cui airgun)	217 dB peak at 100 m 185 dB SEL at 100 m 197 dB rms at 100 m	<300 Hz	Austin and Warner 2012; 81 FR 47239
3D seismic survey (2400 cui airgun)	217 dB peak at 100 m 185 dB SEL at 100 m 197 dB rms at 100 m	<300 Hz	Austin and Warner 2012; 81 FR 47239
Geohazard Surveys	210- dB rms at 1 m	High resolution sub-bottom profiler: 2-24 kHz Low resolution sub-bottom profiler: 1-4 kHz	Manufacturer specifications
Drive pipe installation	195 dB rms at 55 m	<500 Hz	Illingworth & Rodkin 2014
Vertical seismic profiling	227 dB rms at 1 m	<500 Hz	Illingworth & Rodkin 2014
Vibratory sheet pile driving (Iniskin Peninsula causeway)	175 dB peak at 10 m 160 dB SEL at 10 m 160 dB rms at 10 m	<100-2,500 Hz	Illingworth & Rodkin 2007
Water jet	176 dB rms at 1 m	500 Hz – 2 kHz	Austin 2017

6.2.1.2 Exposure Estimates

In the ITR, NMFS Permits Division only authorizes "take" for acoustic harassment. This section describes the factors used to estimate Level A and B acoustic harassment and the estimated acoustic harassment for the ESA-listed species.

Calculating Marine Mammal Acoustic Harassment for the Hilcorp Alaska Oil and Gas Activities in Cook Inlet

NMFS Permits Division estimated the instances of exposure for each species to received levels of impulsive (>160 dB rms) and non-impulsive (> 120dB rms) sounds by considering:

1. the acoustic thresholds above which the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment;
2. the area of water that will be ensonified above these levels in a day;
3. the density or occurrence of marine mammals within these ensonified areas; and
4. the number of days of activities.

NMFS Permits Division notes that while these basic factors can contribute to a basic calculation to provide an initial prediction of takes, additional information that can qualitatively inform take estimates is also sometimes available (e.g., previous monitoring results or average group size) and considered.

The following sections describe the factors considered when estimating expected marine mammal exposures, including the acoustic thresholds, the area of ensonification (including the distance thresholds), the duration of each activity, and the ESA-listed species densities. Finally, the expected marine mammal exposures per activity were estimated by multiplying the following variables: 1) the area of ensonification (km^2) per day, 2) the marine mammal density (# of marine mammals/km^2 throughout the entirety of Cook Inlet), and 3) the duration of activity (in days).

Acoustic Threshold

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). 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; 83 FR 28824; June 21, 2018). 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[15], expressed in root mean square[16] (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 (non-impulsive) sound: 120 dB re 1μPa_{rms}

Under the PTS/TTS Technical Guidance, 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 (NMFS 2016b). Different thresholds and auditory weighting functions are provided for

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[15] 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.
[16] Root mean square (rms) is the square root of the arithmetic average of the squared instantaneous pressure values.

different marine mammal hearing groups, which are defined in the Technical Guidance (NMFS 2018a). The generalized hearing range for each hearing group is in Table 14.

Table 14. Underwater marine mammal hearing groups NMFS 2018.

Hearing Group	ESA-listed Marine Mammals In the Project Area	Generalized Hearing Range[1]
Low-frequency (LF) cetaceans *(Baleen whales)*	humpback and fin whale	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans *(dolphins, toothed whales, beaked whales)*	Cook Inlet beluga whale	150 Hz to 160 kHz
High-frequency (HF) cetaceans *(true porpoises)*	None	275 Hz to 160 kHz
Phocid pinnipeds (PW) *(true seals)*	None	50 Hz to 86 kHz
Otariid pinnipeds (OW) *(sea lions and fur seals)*	Steller sea lion	60 Hz to 39 kHz
[1]Respresents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 db threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall et al. 2007a) and PW pinniped (approximation).		

The PTS onset 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 (Table 15).

Level A harassment radii can be calculated using the optional user spreadsheet[17] associated with NMFS Acoustic Guidance, or through modeling.

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

Table 15. PTS Onset Acoustic Thresholds (NMFS 2018a).

Hearing Group	PTS Onset Acoustic Thresholds* (Received Level)	
	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 1µPa^{2}s. 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.

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 issued guidance interpreting the term "harass" under the ESA as a means 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). For the purposes of this consultation, any action that amounts to incidental harassment under the MMPA—whether Level A or Level B—constitutes an incidental "take" under the ESA and must be authorized by the ITS (Section 10 of this opinion).

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.

Area of Ensonification

The area of ensonification is the area of water that will be ensonified above the acoustic thresholds in a day. Here, we describe operational and environmental parameters of the activity that were used to identify the area ensonified, which include source levels and transmission loss coefficient. Using the sound source levels, then applying the conventional practical spreading equation (with a transmission loss coefficient of 15) yields a 160 dB and a 120 dB Level B acoustic harassment threshold distance for impulsive and non-impulsive sound sources, respectively (Table 18). The distance thresholds were calculated (Table 18) and then applied to the area ensonified (Table 19). The area of ensonification was calculated differently depending on the type of the source; and therefore, is described below per activity.

Seismic Activity

2D Seismic Survey – The area of ensonification for the 2D seismic survey was calculated by multiplying the radius (km) of the NMFS thresholds (Level A harassment radius from NMFS User Spreadsheet and Level B harassment radius to the 160 dB isopleth) by the length of the line (km) to be surveyed each day. The in-water source line is 6 km in length and only one line will be surveyed each day. Therefore, the line length surveyed each day for the 2D seismic survey is 6 km.

3D Seismic Survey – The area of ensonification for the 3D seismic survey was calculated by multiplying the radius (km) to the NMFS thresholds by the length of the line (km) to be surveyed each day. The line length is approximately 27.78 km (15 nm), which will take approximately 3.75 hrs to survey at a vessel speed of 4 knots (7.5 km/hr) with a turn of 1.5 hrs. In a 24-hr period, assuming no delays, the survey team will be able to collect data on 4.5 lines or approximately 127 km. However, delays from weather, equipment, and marine mammals make this level of seismic effort extremely unlikely on a daily basis. Similar 3D seismic projects in Cook Inlet indicate that seismic activity occurs approximately 50 percent of the time over the duration of the project (Lomac-MacNair et al. 2013, Kendall et al. 2015). To account for these delays, we estimated an average reduction of 42 percent in daily seismic operations. This estimate includes approximately 20 percent reduction in effort per day due to weather, 12 percent due to equipment issues, and 10 percent due to work stoppages to minimize effects to marine mammals. Consequently, we estimate the survey team will be able to collect data on an estimated 2.66 lines or approximately 74 km in a 24-hr period.

The distance in between line lengths is 3.7 km (2 nm), so there will be overlap of the area of ensonification, resulting in an overestimation of exposures per day should adjacent lines be surveyed in the same day. To account for this, the total area of ensonification was calculated on a daily basis using GIS. The Level B radii were added to each track line estimated to be traveled in a 24-hour period, and when there was overlapping areas, the resulting polygons were merged to one large polygon to eliminate the chance that the areas could be summed multiple times over the same area. An example of the overall daily ensonified area is illustrated in Table 19 and shown on Figure 33 (only showing Level B).

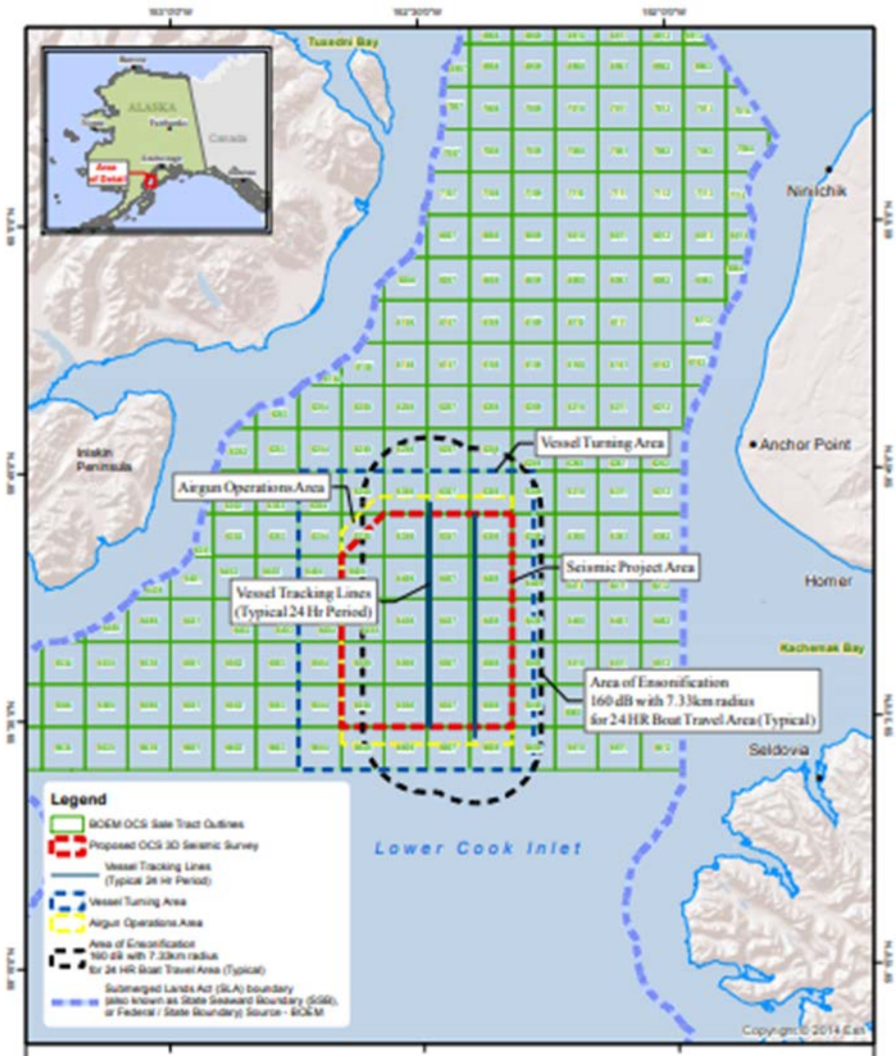

Figure 33. Total area of ensonification in a given day for 3D seismic survey using GIS for Level B (km^2).

Geohazard and Geotechnical Surveys

<u>Geohazard Sub-bottom Profiler for Well Sites</u> – The area of ensonification for the sub-bottom profiler used during the geohazard surveys for the well sites was calculated by multiplying the radii (in km) to the NMFS thresholds by the length of the line (in km) to be surveyed each day. Assuming a grid overlaying a well site and transects will be surveys within the grid. The maximum required surveying distance from the well site per BOEM is 2,400 m on either side of the well site or a total length of 4,800 m in length and the minimum transect width is 150 m. Therefore, the total maximum number of transects within the grid to be surveyed is 32 (4,800 m / 150 m). The total distance surveyed is 153.60 km (4.8 km x 32 transects). Assuming a vessel speed of 4 knots (7.41 km/hr), we estimate it will take approximately 0.65 hrs (38 minutes) to survey a single transect of 4.8 km (time = distance / rate). Assuming the team is surveying for 50 percent of the day (or 12 hrs), the total number of days it will take to survey the total survey grid is 7.77 days (0.65 hr x 12 hr). Similar to the 3D seismic survey, there will be overlap of the

sound because of the distance in between the transects. However, because the area and grid to be surveyed depends on the results of the 3D survey and the specific location, this overestimate was used to estimate the ensonified area conservatively. The total line length to be surveyed per day is 19.76 km (total distance to be surveyed 153.6 km/total days 7.77).

<u>Geohazard Sub-Bottom Profiler for Pipeline Maintenance</u> **–** The area of ensonification for the sub-bottom profiler used during geohazard surveys for the pipeline maintenance. The area of ensonification for the sub-bottom profiler used during geohazard surveys for the pipeline maintenance was calculated by multiplying the radii (in km) to the NMFS thresholds by the length of the line (in km) to be surveyed each day. The assumed transect grid is 300 m x 300 m with 150 m transect widths and 4 transects per grid, therefore the total length to be surveyed is 2,400 m (2.4 km). Assuming a vessel speed of 4 knots (7.41 km/hr), it will take approximately 0.08 hrs (4.86 min) to survey a single transect. The total number of days it will take to survey the grid is 1 day. Similar to the 3D seismic survey, there will be overlap of the sound because of the distance in between the transects. However, because the area and grid to be surveyed depends on the results of the 3D survey and the specific location, this overestimate was used to estimate the ensonified area conservatively. The total line length to be surveyed per day is 2.4 km.

Other sources

For stationary sources, the area of a circle to the relevant Level A or Level B harassment isopleths was used to determine ensonified area. These sources include: pipe driving, VSP, vibratory sheet pile driving, and water jets.

Calculated Distances to Thresholds and Ensonified Area

When the NMFS Technical Guidance (2016) was published and then updated in 2018 (NMFS 2018a), in recognition of the fact that ensonified area/volume could be technically challenging to predict because of the duration component in the new thresholds, NMFS developed a User Spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to help predict takes by Level A harassment. We note that because of some of the assumptions included in the methods used for these tools, we anticipate that isopleths produced are typically going to be overestimates of some degree, which may result in some degree of overestimate of Level A harassment take. However, these tools offer the best way to predict appropriate isopleths when more sophisticated 3D modeling methods are not available. NMFS continues to develop ways to quantitatively refine these tools, and will qualitatively address the output where appropriate. For stationary sources such as pipe driving or vibratory pile driving, the NMFS User Spreadsheet predicts the closest distance at which, if a marine mammal remained at that distance the whole duration of the activity, it would not incur PTS. For mobile sources such as seismic airguns or sub-bottom profilers, the User Spreadsheet predicts the closest distance at which a stationary animal would not incur PTS if the sound source traveled by the animal in a straight line at a constant speed. Inputs used in the User Spreadsheet (Table 16 and Table 17), the resulting isopleths (Table 18), and the area ensonified are reported below (Table 19).

Table 16. NMFS User Spreadsheet Inputs for seismic activity, sub-bottom profilers, vertical seismic profilers, and water jets.

Activity	Type of Source	Source Level	Weighting Factor Adjustment	Source Velocity	Pulse Duration	Repetition Rate	Duration per Day
2D/3D seismic	mobile, impulsive	217 dB peak @ 100 m 185 dB SEL @ 100 m	1 kHz	2.05 m/s	0.2 s	every 6 s	N/A
Sub-bottom profiler	mobile, impulsive	212 dB rms @ 1 m	4 kHz	2.05 m/s	0.02 s	every 0.30 s	N/A
VSP	stationary, impulsive	227 dB rms @ 1m	1 kHz	N/A	0.02 s	every 6 s	4 hrs/day
Water jet	stationary, non-impulsive	176 dB rms @ 1 m	2 kHz	N/A	N/A	N/A	3 hrs/day

Table 17. NMFS User Spreadsheet Inputs for pipe driving and vibratory sheet pile driving

Activity	Type of Source	Source Level	Weighting Factor Adjustment	Number of Piles per Day	Strike Duration per Pile	Strike Duration	Number of Strikes per Pile
Pipe driving	Impact pile driving	195 dB rms @ 55 m	2 kHz	1	N/A	0.2 se	25
Vibratory sheet pile	Vibratory pile driving	160 dB rms @ 10 m	2.5 kHz	5	90 min	N/A	N/A

Table 18. Calculated Distance to NMFS Level A and Level B Harassment Thresholds

Activity	Level A															Level B	
	Low Frequency Cetaceans			Mid Frequency Cetaceans			High Frequency Cetaceans			Phocids			Otariids			All Marine Mammals	
	Impulsive		Non-Impulsive	Impulsive		Non-Impulsive	Impulsive		Non-Impulsive	Impulsive		Non-Impulsive	Impulsive		Non-Impulsive	Impulsive	Non-Impulsive
	219 dB pk	183 dB SEL	199 dB SEL	230 dB pk	185 dB SEL	198 dB SEL	202 dB pk	155 dB SEL	173 dB SEL	218 dB pk	185 dB SEL	201 dB SEL	232 dB pk	203 dB SEL	219 dB SEL	160 dB rms	120 dB rms
2D/3D seismic	74	399	--	14	<1	--	1,000	45	--	86	66	--	10	1	--	7,330	--
Sub-bottom profiler	<1	19	--	<1	1	--	5	277	--	<1	12	--	<1	<1	--	2,929	--
Pipe driving	1	638	--	<1	23	--	19	760	--	2	342	--	<1	25	--	1,630	
VSP	3	9,259	--	<1	79	--	46	2,160	--	4	2,782	--	<1	205	--	2,470	--
Vibratory sheet pile driving	--	--	22	--	--	2	--	--	33	--	--	14	--	--	<1		4,642
Water jet	--	--	14	--	--	<1	--	--	13	--	--	8	--	--	<1	--	860

Assumptions summarized in Table 16 and Table 17.
Weighting Factor Adjustment (WFA) only used for SEL calculation
Assumes 15 log practical spreading loss.
Level B zones for 2D/3D seismic, pipe driving, VSP, and water jet were based on measured levels, rather than the extrapolated level using the transmission loss of 15 log. Level B zones for sub-bottom profiler, and vibratory sheet pile driving, were based on source levels and extrapolated using the 15 log transmission loss.

Table 19. Areas of ensonification (km^2)

Activity	Level A															Level B	
	Low Frequency Cetaceans			Mid Frequency Cetaceans			High Frequency Cetaceans			Phocids			Otariids			All Marine Mammals	
	Impulsive		Non-Impulsive	Impulsive		Non-Impulsive	Impulsive		Non-Impulsive	Impulsive		Non-Impulsive	Impulsive		Non-Impulsive	Impulsive	Non-Impulsive
	219 dB pk	183 dB SEL	199 dB SEL	230 dB pk	185 dB SEL	198 dB SEL	202 dB pk	155 dB SEL	173 dB SEL	218 dB pk	185 dB SEL	201 dB SEL	232 dB pk	203 dB SEL	219 dB SEL	160 dB rms	120 dB rms
2D seismic	0.44	2.39	--	0.08	0.00	--	6.00	0.27	--	0.51	0.39	--	0.06	0.01	--	43.98	--
3D seismic[1]	9.34	50.66	--	1.73	0.04	--	127.02	5.71	--	10.89	8.35	--	1.27	0.17	--	754.23	--
Sub-bottom profiler (exploratory)	0.01	0.38	--	0.00	0.02	--	0.09	5.47	--	0.01	0. 24	--	0.00	0.00	--	57.87	--
Sub-bottom profiler (maintenance)	0.00	0.05	--	0.00	0.00	--	0.01	0.68	--	0.00	0.03	--	0.00	0.00	--	7.23	--
Pipe driving	0.00	1.28	--	0.00	0.00	--	0.00	1.82	--	0.00	0.37	--	0.00	0.00	--	8.35	
VSP	0.00	269.34	--	0.00	0.02	--	0.01	14.66	--	0.00	24.32	--	0.00	0.13	--	19.17	--
Vibratory sheet pile driving	--	--	0.00	--	--	0.00	--	--	0.00	--	--	0.00	--	--	0.00	--	67.68
Water jet	--	--	0	--	--	0	--	--	0	--	--	0	--	--	0	--	3.80

[1]1Area of ensonification for 3D seismic survey calculated using GIS using line length to be surveyed in 1 day with overlap of sound for different thresholds.
Assumptions summarized in Table 16 and Table 17.
Weighting Factor Adjustment (WFA) only used for SEL calculation

Assumes 15 log practical spreading loss

Duration of Activity

The duration was estimated for each activity and location (Table 20) and is described below. For some projects, like the 3D seismic survey, the design of the project is well developed; therefore, the duration is well-defined. However, for some projects, the duration is not well developed, such as activities around the lower Cook Inlet well sites, because the duration depends on the results of previous studies and equipment availability. Our assumptions regarding these activities, which were used to estimate duration, are discussed in the following sections.

Table 20. The estimated duration for each activity and location.

Activity	Location	Duration (days)
2D Seismic Activity	Lower Cook Inlet	10
3D Seismic Activity	Lower Cook Inlet	60
Geohazard and Geotechnical Survey Sub-bottom Profiler	Lower Cook Inlet	31.1
	North Cook Inlet Unit	7.7
	Trading Bay Area	15.5
	Middle Cook Inlet maintenance	3
	Lower Cook Inlet	8
Vertical Seismic Profilers	Trading Bay Area	4
	Lower Cook Inlet	12
Pipe Driving	Trading Bay Area	6
	Lower Cook Inlet	20
Vibratory Sheet Pile Driving	Middle Cook Inlet	20
Water Jet	Middle Cook Inlet	21

<u>2D Seismic Survey</u> – A single vessel is capable of acquiring a source line in approximately 1 to 2 hrs and only one source line will be collected in one day to allow for all the node deployments and retrievals, and intertidal and land zone shot holes drilling. There are up to 10 source lines, so assuming all operations run smoothly, there will only be 2 hrs per day over 10 days of airgun activity. The duration that was used to assess exposures from the 2D seismic survey is 10 days.

<u>3D Seismic Survey</u> **–** The total anticipated duration of the survey is 45-60 days, including delays due to equipment, weather, tides, and marine mammal shut downs. The duration that was used to assess exposures from the 3D seismic survey is 60 days.

<u>Geohazard and Geotechnical Surveys (Sub-bottom profiler)</u> **–** Assuming the team is surveying 50 percent of the day (or 12 hrs), the total number of days it will take to survey the total geohazard survey grid for a single well is 7.77 days. This duration was multiplied by the number of wells per site resulting in 31.1 days for the four Lower Cook Inlet OCS wells, 7.7 days for the North Cook Inlet Unit well, and 15.5 days for the two Trading Bay area wells.

The total number of days it will take to survey the geohazard survey grid for a pipeline maintenance is 1 day. This duration was multiplied by the number of anticipated surveys per year (high estimate of 3 per year), for a total of about 3 days.

<u>Drive Pipe</u> **–** It takes approximately 3 days to install the drive pipe per well with only 25 percent

of the day necessary for actual pipe driving. Drive pipe installation is not part of the P&A activities at the North Cook Inlet site or Granite Point development well. This duration was multiplied by the number of wells per site resulting in 12 days for the four lower Cook Inlet wells and 6 days for the two Trading Bay area wells.

Vertical Seismic Profiler **–** It takes approximately 2 days to perform the VSP per well with only 25 percent of the day necessary for actual seismic work. VSP is not part of the P&A activities at the North Cook Inlet site or Granite Point development drilling. This duration was multiplied by the number of wells per site, resulting in 2 days for each of the four lower Cook Inlet wells for a total of 8 days and 4 days for the two Trading Bay area wells.

Vibratory Sheet Pile Driving **–** The total number of days expected to install the sheet pile dock face using vibratory hammers on the rock causeway is 20 days.

Water jets **–** Water jets are only used when needed for maintenance, therefore, the annual duration was estimated to evaluate exposures. It was estimated that a water jet event will occur 3 days a month. Water jets are used during ice- free months, so this duration was multiplied by 7 months (May-November) resulting 21 days.

ESA-listed Species Densities

Beluga whale

Historically, beluga whales were observed in both upper and lower Cook Inlet in June and July (Rugh et al. 2000). However, between 1993 and 1995, less than 3 percent of all of the annual sightings were in the lower inlet, south of the East and West Forelands, hardly any (one whale in Tuxedni Bay in 1997 and two in Kachemak Bay in 2001) have been seen in the lower inlet during these surveys 1996 through 2016 (Rugh et al. 2005, Rugh et al. 2010, Shelden et al. 2015b, Shelden et al. 2017). Because of the extremely low sighting rates, it is difficult to provide an accurate estimate of density for beluga whales in the mid and lower Cook Inlet region outside of the aerial survey period (June). We assume the June and July densities are valid year round, but only because we lack quantitative information to effectively refine this assumption.

As discussed in Section 4.1.1, Goetz et al. (2012) developed a habitat-based model to estimate Cook Inlet beluga density based on seasonally collected data. Using the Goetz et al. (2012) model, data from the GIS files provided by NMFS and the different project locations (Figure 15) the resulting estimated density is shown in Table 21. In some instances a range of densities for middle Cook Inlet was pulled from the Goetz et al. (2012) density map per location of the activity using GIS, then used to estimate exposures because the density depends on the location of the activity and the area the activity covers. For instance for routine maintenance along the pipeline, a combination of densities were used because the length of the pipeline spans a distance where beluga densities changes (Table 21). The water jets would be used on pipelines throughout the middle Cook Inlet region, so the higher density for the Trading Bay area was used.

Other ESA-Listed Species

Density estimates of species other than beluga whales were estimated from the NMFS June aerial surveys conducted for beluga whales between 2000 and 2016 (Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017). There are a number of limitations to using these data to estimate density for marine mammals in Cook Inlet, as these surveys are only flown for a few days in one month every other year, and are designed with Cook Inlet belugas as the target species (which generally results in lower sightings rates for non-targeted species). These data do not represent variations in species distribution across Cook Inlet, so density estimates for species that generally occur only in lower Cook Inlet will be underestimated for activities in middle Cook Inlet but may be overestimated for species that use all of lower Cook Inlet for activities only occurring in part of lower Cook Inlet. Acknowledging these limitations, they represent the best available dataset for marine mammal sightings in Cook Inlet. Table 22 summarizes the maximum marine mammals observed for each year for the survey and area covered. To estimate density, the total number of individuals per species was divided by the area covered. These density estimates were also compared qualitatively to reported sightings contained in marine mammal monitoring reports from other projects in Cook Inlet including, but not limited to, SAE, Apache, and the Cook Inlet Pipeline Cross-Inlet Extension Project, to determine whether the calculated densities were generally similar to the numbers of sightings from these projects.

Table 21. Density estimates for beluga whales.

Area/Activity	NMFS Density[1]	Goetz Density[2]
Lower Cook Inlet OCS (3D seismic, geohazard, pipe driving, VSP)	0.000593	0.0000
Lower Cook Inlet – east side (2D seismic)	0.000593	0.011106
Lower Cook Inlet – west side Iniskin (vibratory sheet pile driving)	0.000593	0.024362
Trading Bay Unit (pipe driving, VSP, geohazard)	0.000593	0.015053
Middle Cook Inlet (routine maintenance: geohazard, water jet)	0.000593	0.001664-0.015053*

[1]Density based on NMFS aerial surveys
[2]Density based on Goetz et al. (2012) for specific area
*A range of densities was used because some activities span a distance or area where beluga densities changes.

Table 22. Density estimates for humpback whales, fin whales, and Steller sea lions.

Species	Estimated Density (# marine mammals/km^2)[1]
Humpback whale	00.001888
Fin whale	00.000331
Steller sea lion	00.008110

[1]When using data from NMFS aerial surveys, the survey year with the greatest calculated density was used to calculate exposures.

Exposure Calculations and Estimation

The information provided above is brought together in this section to produce a quantitative take estimate.

Takes Estimates per Activity per Location

The numbers of each ESA-listed species that could potentially be exposed to sounds associated with the proposed activities that exceed NMFS' acoustic Level A and B harassment criteria were estimated per type of activity and per location. The specific years when these activities might occur are not known at this time, therefore, this method of per activity per location allows for flexibility in operations and provides NMFS with appropriate information for assessing potential exposures. Individual animals may be exposed to received levels above our harassment thresholds more than once per day, but NMFS considers animals only "taken" once per day. Exposures refer to any instance in which an animal is exposed to sound sources above NMFS' Level A or Level B harassment thresholds. We calculated the estimated exposures (without any mitigation) per activity per location by multiplying the density of marine mammals (# of marine mammals/km^2) by the area of ensonification (km^2) and the duration (days per year). These results of these calculations are presented in Table 23 and Table 24 below.

Table 23. Estimated number of Level A exposures per activity and location.

Species	3D Seismic	2D Seismic	Vibratory sheet pile driving	Water Jets	Sub-bottom Profiler				Pipe driving		Vertical seismic profiler		Total
	LCI[1]	LCI[1]	LCI[1]	MCI[2]	LCI[1]	NCI[3]	TB[4]	MCI[2]	LCI[1]	TB[4]	LCI[1]	TB[4]	
Humpback whale	6.80	0.05	0.00	0.00	0.02	0.01	0.00	0.00	0.03	0.01	4.07	2.03	13.01
Fin whale	1.19	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.71	0.36	2.29
Beluga whale[5]	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Beluga whale[6]	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Steller sea lion	0.70	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71

[1]LCI – Lower Cook Inlet, [2]MCI – Middle Cook Inlet, [3]NCI – North Cook Inlet Unit, [4]TB – Trading Bay area, [5]NMFS, [6]Goetz et al. (2012)

Table 24. Estimated number of Level B exposure per activity and location.

Species	3D Seismic	2D Seismic	Vibratory sheet pile driving	Water Jets	Sub-bottom Profiler				Pipe driving		Vertical seismic profiler		Total
	LCI[1]	LCI[1]	LCI[1]	MCI[2]	LCI[1]	NCI[3]	TB[4]	MCI[2]	LCI[1]	TB[4]	LCI[1]	TB[4]	
Humpback whale	85.43	0.83	2.56	0.09	3.40	0.85	1.70	0.04	0.19	0.09	0.29	0.14	95.61
Fin whale	14.99	0.15	0.45	0.02	0.60	0.15	0.30	0.01	0.03	0.02	0.05	0.03	16.78
Beluga whale[5]	26.83	0.26	0.80	0.03	1.07	0.27	0.53	0.01	0.06	0.03	0.09	0.05	30.02
Beluga whale[6]	0.00	4.88	32.98	0.73	0.00	0.75	13.54	0.00	0.00	0.75	0.00	1.15	54.80
Steller sea lion	366.99	3.57	10.98	0.40	14.59	3.65	7.30	0.17	0.81	0.41	1.24	0.62	410.72

[1]LCI – Lower Cook Inlet, [2]MCI – Middle Cook Inlet, [3]NCI – North Cook Inlet Unit, [4]TB – Trading Bay area, [5]NMFS, [6]Goetz et al. (2012)

Take Estimate per Year of Activity

The take estimates by activity and location discussed in the previous section are not representative of the estimated takes per year (i.e., annual takes). It is difficult to characterize each year accurately because many of the activities are progressive (i.e., they depend on results and/or completion of the previous activity). This results in much uncertainty in the timing, duration, and complete scope of work. Each year, Hilcorp will submit an application for an LOA with the specific details of the planned work for that year with estimated take numbers. Table 25 summarizes a realistic scenario of activities considered per year, based on what Hilcorp expects to complete annually. Tables 26 through Table 31 show exposures per year with activities anticipated to occur during each of the years.

Table 25. Summary of activities considered by year.

Year	Activity	Area
June 1 2019-2020	OCS 3D seismic	LCI[1]
	OCS geohazard of 2 wells	LCI
	Pipeline maintenance (geohazard, water jet)	MCI[2]
June 1 2020-2021	Pile driving at Iniskin	LCI (Iniskin)
	OCS drilling activities (geohazard, pipe driving, VSP) at up to 2 wells	LCI
	Trading Bay drilling activities (geohazard, pipe driving, VSP) at 2 wells	TB[3]
	P&A activities (geohazard) at 1 well	NCI[4]
	Pipeline maintenance (geohazard, water jet)	MCI
June 1 2021-2022	OCS drilling activities (geohazard, pipe driving, VSP) at 1 well	LCI
	2D seismic	LCI
	Pipeline maintenance (geohazard, water jet)	MCI
June 1 2022-2023	OCS drilling activities (geohazard, pipe driving, VSP) at 1 well	LCI
	Pipeline maintenance (geohazard, water jet)	MCI
June 2023-2024	Pipeline maintenance (geohazard, water jet)	MCI

[1]LCI – Lower Cook Inlet Wells, [2]MCI – Middle Cook Inlet Pipeline Maintenance, [3]NCI – North Cook Inlet Unit well, [4]TB = Trading Bay wells

Table 26. Estimated Level A and B exposures for the first year of activity.

Species	Level A					Level B				
	LCI	LCI	MCI	MCI		LCI	LCI	MCI	MCI	
	3D seismic	OCS geohazard	Maintenance geohazard	Maintenance water jets	Total	3D seismic	OCS geohazard	Maintenance geohazard	Maintenance water jets	Total
Humpback whale	6.80	0.01	0.00	0.00	6.81	85.43	1.70	0.04	0.09	87.26
Fin whale	1.19	0.00	0.00	0.00	1.19	14.99	0.30	0.01	0.02	15.31
Killer whale	0.07	0.00	0.00	0.00	0.07	14.99	0.58	0.01	0.03	15.61
Beluga whale (NMFS)	0.06	0.00	0.00	0.00	0.06	26.83	0.53	0.01	0.03	27.40
Beluga whale (Goetz et al. 2012)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.73
Steller sea lion	0.70	0.00	0.00	0.00	0.70	366.99	7.30	0.17	0.40	374.85

Table 27. Estimated Level A exposures for the second year of activity.

Species	Level A										
	LCI	LCI	LCI	LCI	NCI	TB	TB	TB	MCI	MCI	
	2D seismic Anchor Point	OCS geohazard	OCS pipe driving	OCS VSP	NCI geohazard	TB geohazard	TB pipe driving	TB VSP	Maintenance geohazard	Maintenance water jets	Total
Humpback whale	0.05	0.01	0.03	4.07	0.01	0.01	0.01	2.03	0.00	0.00	6.23
Fin whale	0.01	0.00	0.01	0.71	0.00	0.00	0.00	0.36	0.00	0.00	1.09
Killer whale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beluga whale (NMFS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beluga whale (Goetz et al. 2012)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Steller sea lion	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Table 28. Estimated Level B exposures for the second year of activity.

Species	Level B										
	LCI	LCI	LCI	LCI	NCI	TB	TB	TB	MCI	MCI	
	2D seismic Anchor Point	OCS geohazard	OCS pipe driving	OCS VSP	NCI geohazard	TB geohazard	TB pipe driving	TB VSP	Maintenance geohazard	Maintenance water jets	Total
Humpback whale	0.83	1.70	0.19	0.29	0.85	1.70	0.09	0.14	0.04	0.09	5.93
Fin whale	0.15	0.30	0.03	0.05	0.15	0.30	0.02	0.03	0.01	0.02	1.04
Beluga whale (NMFS)	0.26	0.53	0.06	0.09	0.27	0.53	0.03	0.05	0.01	0.03	1.86
Beluga whale (Goetz et al. 2012)	4.88	0.00	0.00	0.00	0.75	13.54	0.75	1.15	0.00	0.73	21.82
Steller sea lion	3.57	7.30	0.81	1.24	3.65	7.30	0.41	0.62	0.17	0.40	25.46

Table 29. Estimated Level A and B exposures for the third year of activity.

Species	Level A							Level B						
	LCI	LCI	LCI	LCI	MCI	MCI	Total	LCI	LCI	LCI	LCI	MCI	MCI	
	Pile driving	OCS geohazard	OCS pipe driving	OCS VSP	Maintenance geohazard	Maintenance water jets		Pile driving	OCS geohazard	OCS pipe driving	OCS VSP	Maintenance geohazard	Maintenance water jets	Total
Humpback whale	0.05	0.01	0.01	1.02	0.00	0.00	1.08	2.56	0.85	0.05	0.07	0.04	0.09	3.66
Fin whale	0.00	0.00	0.00	0.18	0.00	0.00	0.18	0.45	0.15	0.01	0.01	0.01	0.02	0.64
Beluga whale (NMFS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.27	0.01	0.02	0.01	0.03	1.15
Beluga whale (Goetz et al. 2012)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.98	0.00	0.00	0.00	0.00	0.73	33.71
Steller sea lion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.98	3.65	0.20	0.31	0.17	0.40	15.71

Table 30. Estimated Level A and B exposures for the fourth year of activity.

Species	Level A						Level B					
	LCI	LCI	LCI	MCI	MCI		LCI	LCI	LCI	MCI	MCI	
	OCS geohazard	OCS pipe driving	OCS VSP	Maintenance geohazard	Maintenance water jets	Total	OCS geohazard	OCS pipe driving	OCS VSP	Maintenance geohazard	Maintenance water jets	Total
Humpback whale	0.01	0.01	1.02	0.00	0.00	1.03	0.85	0.05	0.07	0.04	0.09	1.10
Fin whale	0.00	0.00	0.18	0.00	0.00	0.18	0.15	0.01	0.01	0.01	0.02	0.19
Beluga whale (NMFS)	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.01	0.02	0.01	0.03	0.34
Beluga whale (Goetz et al. 2012)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.73
Steller sea lion	0.00	0.00	0.00	0.00	0.00	0.00	3.65	0.20	0.31	0.17	0.40	4.73

Table 31. Estimate Level A and B exposures for the fifth year of activity.

Species	Level A			Level B		
	MCI	MCI		MCI	MCI	
	Maintenance geohazard	Maintenance water jets	Total	Maintenance geohazard	Maintenance water jets	Total
Humpback whale	0.00	0.00	0.00	0.04	0.09	0.13
Fin whale	0.00	0.00	0.00	0.01	0.02	0.02
Beluga whale[1] (NMFS)	0.00	0.00	0.00	0.01	0.03	0.04
Beluga whale (Goetz et al. 2012)	0.00	0.00	0.00	0.00	0.73	0.73
Steller sea lion	0.00	0.00	0.00	0.17	0.40	0.57

Summary of Takes

Point-in-time surveys (such as aerial surveys) report what is present in a region at a particular time. For example, aerial surveys of Cook Inlet reported 169 humpbacks over the course of 16 years during early summer (June or early July), suggesting on the order of 10 humpbacks present in Cook Inlet during each June/early July (10 distinct animals that could be affected by project activities during this time of year). In contrast, individuals of any given species may each be taken on multiple occasions (once per day) should they remain in proximity to project activities, which is why the expected or proposed take can far exceed the number of animals expected to be present in the region (based on point-in-time surveys).

NMFS Permits Division is issuing regulations under the MMPA to govern the unintentional taking of marine mammals incidental to Hilcorp oil and gas activities in Cook Inlet, Alaska, over the course of five years (2019-2024). These ITRs, allow for the issuance of an LOA on an annual basis for the incidental take of marine mammals under the MMPA. The regulations estimate the potential take and impacts from the proposed action over 5-years, where as the annual LOA authorizes the actual take. Unlike the MMPA, under the ESA section 7 consultation NMFS AKR authorizes take based on what is expected to occur during the entire 5-year project, regardless of the year in which take may occur. The ITR outlines which year each activity is expected to occur, however, due to unforeseen circumstances the year in which an activity occurs may change. Therefore, in order to analyze the impact to a population in any given year, NMFS Permits Division determined the maximum amount of take under the MMPA they would authorize in an annual LOA (Table 32). The estimated take over the 5-year regulation is summarized in Table 33.

Based on the results of the acoustic harassment analysis, NMFS Permits Division proposes the following maximum annual Level B takes: 90 humpback whales (10.4 percent of the population), 15 fin whales (1.64 percent of the population), 35 beluga whales (10.67 percent of the population), and 375 Steller sea lions (0.74 percent of the population) and are based on the year with activities that estimated the maximum exposures for a species. The proposed maximum annual Level B takes for all species are rounded from the exposure estimate to the nearest increment of 5. NMFS Permits Division proposes a maximum annual Level A takes for humpback whales (7; 0.81 percent of the population), fin whales (1; 0.10 percent of the population), and Steller sea lions (1; 0 percent of the population; Table 32). No annual Level A takes are authorized for beluga whales. We do not anticipate that any of the activities will result in mortality or serious injury to ESA-listed species, but these species may be exposed to Level A SEL levels.

Over the entire 5-year period covered by the ITR, NMFS Permits Division estimates they will authorize the following total number of Level B takes: 99 humpback whales, 18 fin whales, 58 beluga whales, and 422 Steller sea lions (Table 33). Each Level B take for the 5-year period was rounded from the exposure estimate to a whole number. Of the 99 humpback whales, 10.5 percent or 11 animals are predicted to be from the Mexico DPS and 0.5 percent or 1 animal is predicted from the Western North Pacific DPS (Wade et al. 2016). Therefore, NMFS AKR is authorizing 11 Level B harassment takes for the Mexico DPS and 1 Level B harassment take for Western North Pacific DPS under the ESA.

Over the 5-year regulation, NMFS Permits Division has estimated Level A takes of: 16 humpback whales, 5 fin whales, and 5 Steller sea lion (Table 33). The proposed Level A takes for fin whales and Steller sea lions were rounded up to account for group size. No Level A take of belugas whales is permitted over the 5-year regulation. Of the16 humpback whales, 10.5 percent or 2 animals are predicted to be from the Mexico DPS and 0.5 percent or 0 animals are predicted from the Western North Pacific DPS (Wade et al. 2016). Therefore, NMFS AKR is authorizing 2 Level A takes for the Mexico DPS and 0 Level A take for Western North Pacific DPS under the ESA. Because it is not possible to identify a humpback whale by DPS in the field, NMFS AKR uses the estimated percentage of humpback whales by DPS to determine the number of listed animals that have been taken. As a result, NMFS AKR will not consider that Hilcorp has reached its ESA take limit until 99 humpback whales have been observed in a Level A or Level B zone.

Section 10, *Incidental Take Statement*, of this opinion discusses the level of anticipated take we expect for the proposed Hilcorp Alaska gas and oil activities in Cook Inlet, Alaska.

Table 32. Maximum annual Level A and B takes within any given year under proposed MMPA permits.

Species	Level A				Level B			
	Maximum Annual Estimated Exposures[1]	Maximum Annual Takes	Population Estimate	% of Population	Maximum Annual Estimated Exposures	Maximum Annual Takes[2]	Population Estimate	% of Population
Humpback whale	6.81	7	865	0.81%	87.26	90	865	10.40%
Fin whale	1.19	1	1,036	0.10%	15.31	15	1,036	1.64%
Beluga whale	0.02	0	328	0%	33.71	35	328	10.67%
Steller sea lion	0.70	1	50,983	0%	374.85	375	50,983	0.74%

[1]These values are based on the year with activities that estimated the maximum exposure for a species.

[2]NMFS Permit Division rounded the Level B takes to the nearest increment of 5.

Table 33. Total maximum Level A and B takes authorized over the entirety of the 5-year regulations.

Species	Level A		Level B	
	Estimated Exposures	Takes	Estimated Exposures	Takes
Humpback whale	15.15	16	98.07	99
Fin whale	2.65	5	17.21	18
Beluga whale	0.02	0	57.73	58
Steller sea lion	0.71	5	421.31	422

6.2.1.3 Seismic Surveys and Vertical Seismic Profiling

Hilcorp Alaska plans to conduct 2D and 3D seismic surveys and VSP during oil and gas exploration (Section 2.1.1). The 2D seismic surveys will take place along the Kenai Peninsula from the Kasilof River south to Anchor Point over a 30-day period in either 2021 or 2022 with 10 days of actual seismic activity (Section 2.1.1). During 2D seismic activity, operations will occur for up to 2 hr per day. The 3D seismic surveys will take place offshore in the Federal OCS blocks in either 2019 or 2020 for 45-60 days (Section 2.1.1). 3D seismic operations will be active 24 hrs per day, in-water airguns will be active for approximately 3-5 hrs, followed by a 1.5 hr period to turn around and reposition the vessel for the next transect, which results in approximately 15 to 17 hrs of active airguns per day. VSP will take place in the Federal OCS blocks in 2020 to 2022 for 12 days and in the Trading Bay Unit in 2020 for four days once drilling is complete. VSP usually takes less than two full days at each well site.

2D Seismic Surveys –The airgun array Hilcorp Alaska plans to use for the 2D survey is unknown at this time; however, Hilcorp intends to use an array similar to previous seismic surveys conducted in Cook Inlet by Apache and SAExploration: either a 2,400 cui array or 1,760 cui array (Section 2.1.1). The source vessel will also be equipped with a 440 cui shallow water source which can be deployed at high tide in the intertidal area in less than 1.8 m (6 ft) of water. Apache conducted a sound source verification (SSV) for the 440 cui and 2,400 cui arrays in 2012 ((Austin and Warner 2012); 81 FR 47239). The SSV was located in Beshta Bay on the western side of Cook Inlet (between Granite Point and North Forelands). Water depths ranged from 30-70 m (98-229 ft).

The 440 cui airgun array measured sound levels for the broadside direction were 217 dB peak, 190 dB SEL, and 201 dB rms at a distance of 50 m. The estimated distance to the 160 dB rms (90^{th} percentile) threshold assuming the empirically measured transmission loss of 20.4 log R was 2,500 m. Sound levels near the source were highest between 30 and 300 Hz in the endfire direction (i.e., along the transect line) and between 20 Hz and 300 Hz in the broadside direction (i.e., perpendicular to the transect line).

The 2,400 cui airgun array measured sound levels for the endfire direction were 217 dB peak, 185 dB SEL, and 197 dB rms at a distance of 100 m. The estimate distance to the 160 dB rms (90^{th} percentile) thresholds assuming the empirically measured transmission loss of 16.9 log R was 7,770 m. Sound levels near the source were highest between 30 and 150 Hz in the endfire direction (i.e., along the transect line) and between 50 and 200 Hz in the broadside direction (i.e., perpendicular to the transect line). However, as part of the Apache ITR process, JASCO provided an updated distance of 7,330 m for a 24-hour survey (81 FR 47239). We used the distance of 7,300 m for estimation of exposure for the 2D and 3D seismic surveys to be consistent with the Apache ITR. It is important to note that neither survey by Hilcorp Alaska is expected to use an airgun array of 2,400 cui; both will almost certainly be less than this.

3D Seismic Surveys – Hilcorp Alaska plans to collect 3D seismic data in the Federal OCS waters in lower Cook Inlet over a 45 to 60 day period in 2019 using a 1,945 cui airgun array (Section 2.1.1 project description). No source levels for seismic activity using a 1,945 cui airgun array have been measured in Cook Inlet. Therefore, for the purposes of estimating Level A and B acoustic harassment, measured sound source levels from the 2,400 cui airgun array (217 dB peak, 185 dB SEL, and 197 dB rms at a distance of 100 m) from the previous seismic surveys in Cook Inlet conducted by Apache and SAExploration were used to determine the distance threshold (7,330 m from the JASCO updated distance) and estimate Level A and B acoustic harassment.

Hilcorp Alaska, in coordination with NMFS, plan to perform a SSV study at the start of seismic activity (2019 or 2020) to determine the sound source levels of the seismic activity that will ensonify to 160 dB and 120 dB re 1µPa$_{rms.}$ The results from the SSV study may improve our understanding of the radius within which take will occur.

Vertical Seismic Profiling (VSP) – VSP is acoustic sources associated with exploratory drilling activities (i.e., drilling and P&A) that may cause Level A or B acoustic harassment. Once the drilling of a well is complete, accurate follow-up seismic data may be collected by placing a receiver at known depths in the borehole and shooting a seismic airgun at the surface near the borehole, called VSP. The actual size of the airgun array is not determined until the final well depth is known, however, typical airgun array volumes used for VSP are between 600 and 880 cui. VSP usually takes less than two full days at each well site. (Illingworth and Rodkin 2014) measured sound source levels at 227 dB at 1 m for a 720 cui array for Buccaneer in 2013, with underwater levels exceeding 160 dB rms distance threshold at 2.47 km (1.54 mi).

Effects from Airgun Noise

Studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers (Richardson and Würsig 1997, Goold and Fish 1998), but they do not necessarily cause behavioral disturbances. Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, environmental conditions, and many other factors (Richardson et al. 1995, Southall et al. 2007b). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a short distance, the impacts from this change are unlikely to be significant to the individual, let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be significant (e.g., Weilgart 2007). Displacement from important feeding/breeding areas is not anticipated from the proposed seismic activity because most primary feeding and suspected breeding areas are not located in or immediately adjacent to the areas where seismic activity will occur (NMFS 2015).

Numerous studies showed that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even when pulsed sounds must be readily audible to the animals, based on measured received levels and the hearing sensitivity of that marine mammal group. 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. In general, pinnipeds and small odontocetes are more tolerant of exposure to airgun pulses than baleen whales. Humpback whales, gray whales, and other large baleen whales have shown strong overt reactions to impulsive noises, such as seismic operations, at received levels between 160 and 173 dB re 1 µPa rms (Richardson et al. 1986, Ljungblad et al. 1988, McCauley et al. 2000, Miller et al. 2005, Gailey et al. 2007). The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important, but unknown, degree by a seismic program are based on behavioral observations while studying several marine mammal species, including gray whales, bowhead whales, and ringed seals. The criteria established for these marine mammals, which are applied to other marine mammals, are conservative and have not been demonstrated to significantly affect individuals or marine mammal populations in Alaska waters. For example, monitoring seismic work within the Beaufort and Chukchi seas indicated that exposures to these noise levels have not resulted in serious injury or mortality, changes in localized abundance, or changes to the stocks' growth or recovery.

Stone and Tasker (2006) suggested that the different species of cetaceans may adopt different strategies for responding to sound exposure from seismic surveys. For example, some small odontocetes typically move out of the immediate area, while slower-moving mysticetes orient away from the vessel and increase their distance from the source but do not vacate the area. Weir (2008) reported no significant differences in encounter rates (sightings/hr) for humpback and sperm whales during seismic and non-seismic operations. There is some evidence indicating that increased noise increases stress in right whales, which results in unknown long-term effects (Rolland et al. 2012). As previously mentioned, various baleen whales and toothed whales have temporarily reacted behaviorally to airgun pulses under some conditions, at other times they have shown no overt reactions.

Airgun-induced masking of marine mammal calls and other natural sounds are expected to be limited (geographically and temporally) during Hilcorp Alaska's seismic activity. Some whales are known to continue calling in the presence of seismic pulses, as their calls were heard between seismic pulses (Richardson et al. 1986, McDonald et al. 1995, Greene et al. 1999, Nieukirk et al. 2004). Airguns typically produce most noise energy in the 10 to 120 Hertz (Hz) range, with some energy extending to 1 kHz (Richardson et al. 1995). Although these sounds are within the hearing ranges for the Cook Inlet beluga whales, humpback whales, fin whales, and western DPS Steller sea lions, masking only exists for the duration of time that the masking sound is emitted, and is therefore considered short-term.

Beluga Whales

Little information is available on beluga whale reactions to noise pulses. Beluga whales have been observed to exhibit changes in behavior when exposed to strong, pulsed sounds, similar in duration to those typically used in seismic surveys (Finneran et al. 2000, Finneran et al. 2002, Finneran et al. 2005). Captive beluga whales sometimes vocalized after exposure and were reluctant to station at the test site for subsequent exposures (Finneran et al. 2000, Finneran et al. 2002, Finneran et al. 2005). However, the animals tolerated high received levels of sound (peak-peak level more than 200 dB re 1 μPa) before exhibiting aversive behaviors (Richardson et al. 1995). Some beluga whales summering in the eastern Beaufort Sea may have avoided the specific seismic operations area (two arrays with 24 airguns per array), which used a larger array than that of this proposed program (two arrays of 12 airguns per array), by 10 to 20 km (6.2 to 12.4 mi), although beluga whales occurred as close as 1,540 m (957 mi) to the line of seismic operations (Miller et al. 2005). The proposed seismic program may affect beluga whales in the action areas; however, the seismic activity is short-term, localized and will implement mitigation and monitoring measures described in Section 2.1.2 to reduce impacts from noise associated with the seismic activity on beluga whales.

Beluga whales' response to a seismic program is difficult to accurately predict. The most likely response to seismic noise is expected to be short-term, localized avoidance. For example, beluga whales in the Mackenzie River estuary, eastern Beaufort Sea, moved away during construction on an artificial island, but did not leave the construction area (Richardson et al. 1995). It is unclear, however, if beluga whales truly avoided the seismic operations in the eastern Beaufort Sea, or if the observed movement was natural offshore migration during that time of year.

Examples from scientific studies and opportunistic sightings suggest that beluga whales are tolerant of many types of in-water noise. Cook Inlet whales continue to use habitats in Knik Arm, despite heavy disturbance and underwater noise from maritime operations, maintenance dredging, aircraft operations, and pile driving for the POA expansion. 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. Some beluga whales repeatedly exposed to noise may habituate to the sounds and, upon subsequent exposures, may not change their behavior or distribution when exposed to those sounds; the proposed seismic activities may not have substantial effects on animals that habituate to sounds from this project or to similar sounds.

A seismic program in Cook Inlet during 2012 operated a boat and land-based monitoring program that documented behavior when whales were first sighted, regardless of airgun activity (Lomac-MacNair et al. 2013). Of the 55 Cook Inlet beluga whale sightings, 17 (31 percent) were made when the airguns were operational. All documented behaviors without airgun activity were also documented when the airguns were operating, and included, in order of most frequently observed to least frequently observed behavior: traveling, milling, unknown behavior when whales were too far, swimming, foraging, and diving (

Figure 34). It is possible that some individual Cook Inlet beluga whales avoided areas actively or recently subjected to seismic surveys in 2012; however, the observed behaviors did not suggest there was a significant or meaningful alteration in behavior. The end-of-season or '90 Day' report on the 2012 monitoring program for seismic activities compared the beluga whales' location (closest approach distance) relative to the seismic vessel (Lomac-MacNair et al. 2013). These data clearly indicated that beluga whales were locally more abundant and closer when there was no seismic activity, than when seismic activity occurred, with avoidance at distances out to 5 km (3.1 m) from the array; however, no relationship beyond this distance is apparent (Figure 35), possibly reflecting drop-off in observer efficiency at these distances. Beluga whales' fidelity to feeding, molting, and calving areas, coupled with the beluga whale's demonstrated tolerance of in-water noise, indicates they will likely continue to access these sites once the surveys in the area are completed.

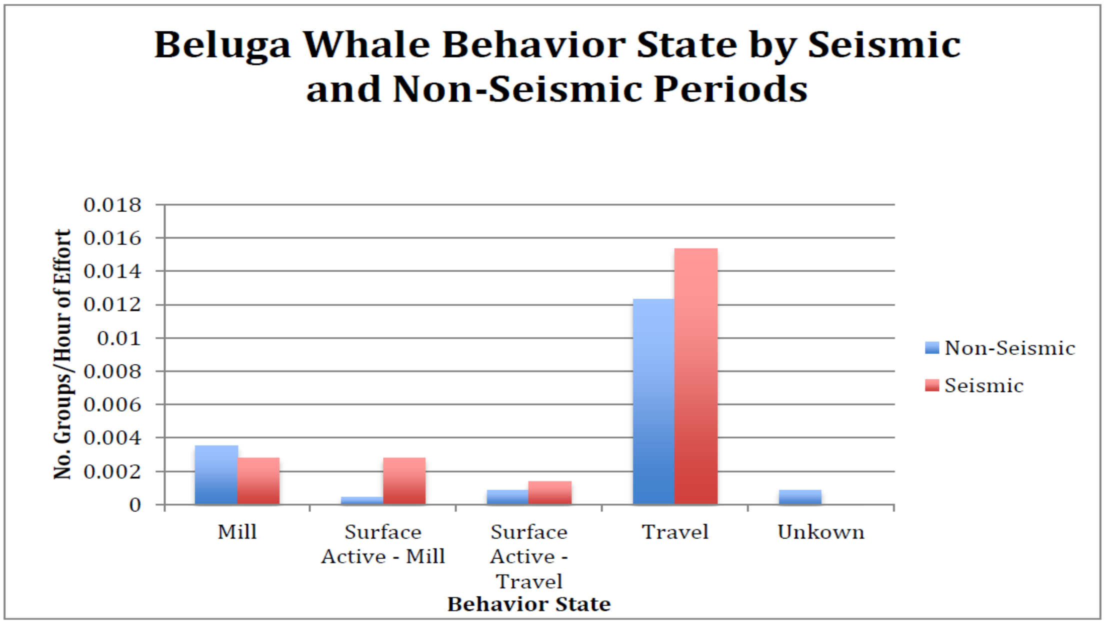

Figure 34. Initial behaviors by Cook Inlet beluga whales observed during times with and without seismic airgun activity during May 6-September 30, 2012. Approximately 3,029.2 hours of effort were expended in obtaining this data (Lomac-MacNair et al. 2013).

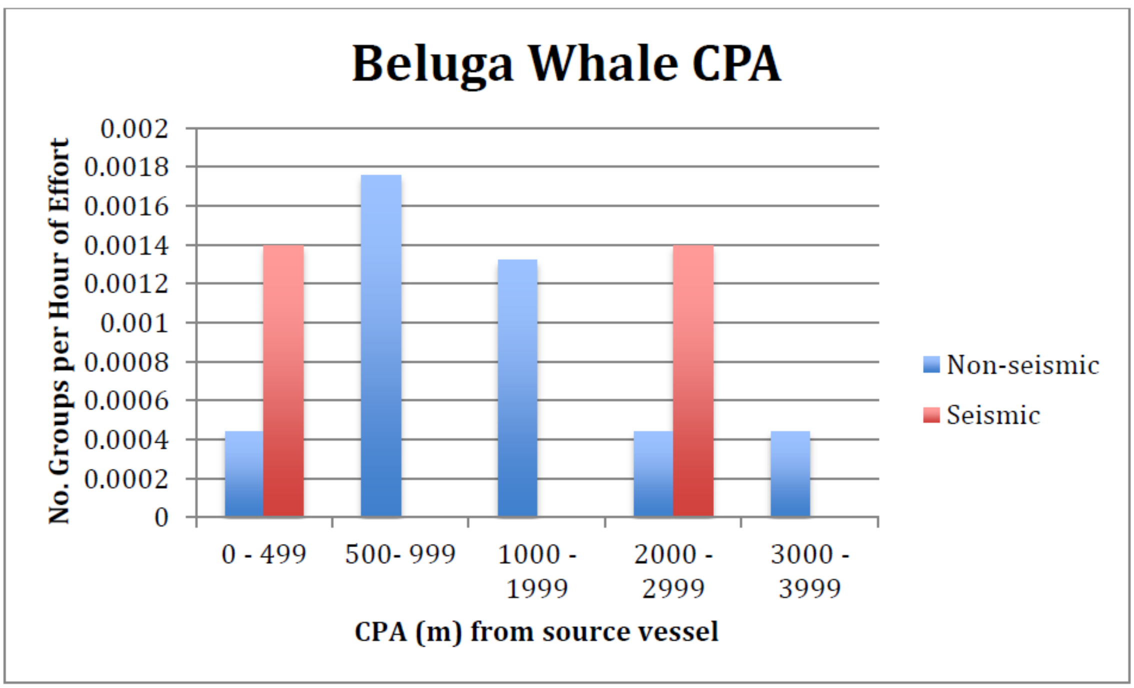

Figure 35. The closest point of approach (CPA) by beluga whales to the source vessel(s) during times with and without seismic airgun activity during 2014, with 3,029.2 hours of observational effort (Lomac-MacNair et al. 2013).

During June 2012, NMFS's annual aerial survey consistently documented Cook Inlet beluga whales near West Foreland and MacArthur River, Trading Bay. Beluga whales have not been sighted in this general area during NMFS surveys since 2001; and repeated sightings have not been documented since 1995 (Shelden et al. 2013). NMFS does not have evidence to explain the cause or the circumstances that resulted in repeated beluga whale sightings in this area in 2012.

However, potential explanations for this occurrence include: natural behavior of beluga whales, which historically were documented in the Trading Bay region; available and adequate food sources in the MacArthur River area in June; or an acoustic or other perceived barrier affecting the whales' movements into the uppermost portions of Cook Inlet, resulting from the 2012 seismic program. Although evidence does not demonstrate a causal relationship between the circumstances present in 2012, one possible explanation is that the repeated beluga whale sightings near West Foreland/Trading Bay during June 2012 resulted from beluga avoidance of the area from the seismic program. Regardless of explanation, there was no indication that displacement was permanent (NMFS 2015).

Masking effects from seismic pulses are expected to be negligible for belugas because the intermittent pulses amply allow for detection of sound between pulses, and because sounds important to beluga whales are predominantly at much higher frequencies than are airgun sounds. Therefore, the potential problem from auditory masking for beluga whales is diminished by the small amounts of frequency overlap between sounds produced by airguns (less than 1 kHz), those produced by beluga whale calls (0.26 to 20 kHz; (Schevill and Lawrence 1949, Sjare and Smith 1986b, Sjare and Smith 1986a)), and beluga echolocation sounds (40 to 60 kHz and 100 to 120 kHz; (Au 1993)).

Romano et al. (2004) demonstrated that beluga whales exposed to seismic water gun and/or single pure tones (SPLs up to 201 dB) resembling sonar pings, showed increased stress hormone levels of norepinephrine, epinephrine, and dopamine. However, in two studies, captive beluga whales exposed to playbacks of drilling noise did not result in increased levels of stress-related hormones (Thomas et al. 1990). Wright et al. (2007) concluded that anthropogenic noise, both by itself or in combination with other stressors, can reduce the fitness in individual marine mammals and may have population-level consequences. The available literature suggests stress hormone levels may be affected by noise exposure, but the results are highly variable and dependent (in part) upon factors such as: duration, marine mammal species, intensity of sound, frequency, individual's response, and amount of control the individual has over the stressor. The physiological effects from any elevation in hormone levels are equally variable.

<u>Hearing Impairment in Cook Inlet Beluga Whales –</u> The RMS level of an airgun pulse is typically 10 to 15 dB higher than the SEL for the same pulse when received within a few kilometers of the airguns. Therefore, a single airgun pulse might need to have a received level of approximately 196 to 201 dB to produce brief, mild TTS. Exposure to several strong seismic pulses, each with a flat weighted received level near 190 dB RMS (175 to 180 dB SEL), could result in the cumulative exposure of approximately 186 dB SEL, and thus slight TTS in a beluga. When estimating the amount of sound energy required for the onset of TTS, it is generally assumed that effects from a given cumulative SEL from a series of pulses is the same as if that amount of sound energy were received as a single strong sound (Southall et al. 2007b). However, some recovery may occur between pulses, and it is not currently known how this may affect the TTS threshold. More data are needed in order to determine the received levels at which beluga

whales would start to incur TTS upon exposure to repeated, low-frequency pulses of airgun sounds with variable received levels. For example, the total energy received by an animal will be a function of received levels from airgun pulses as an airgun array approaches, passes at various distances, and moves away (Erbe and King 2009).

Humpback and Fin Whales

As stated previously, humpback whales, gray whales, and other large baleen whales have shown strong overt reactions to impulsive noises, such as seismic operations, at received levels between 160 and 173 dB re 1 μPa rms (Richardson et al. 1986, Ljungblad et al. 1988, McCauley et al. 2000, Miller et al. 2005, Gailey et al. 2007). However, baleen whales seem to be even less tolerant of continuous noise (Richardson and Malme 1993), often detouring around drilling activity when received levels are as low as 119 dB re 1 μPa rms (Malme et al. 1983, Richardson et al. 1986).

The intense pulses produced by seismic surveys clearly have the potential to cause direct or behaviorally-mediated physiological harm at close distances (Gordon et al. 2003), but more subtly at longer distances there exists the potential of disturbing animals and altering important behaviors, as well as masking acoustic signals and negatively affecting communication. For example, the number of singing humpback whales was found to decrease significantly with increasing received level of seismic survey noise (Cerchio et al. 2014). Miller et al. (2000) documented lengthening of humpback songs for those individuals that did not cease singing in response to LFA signals, and also suggested a compensation mechanism to increase redundancy similar to that suggested for blue whale calls (Di Lorio and Clark. 2010). While Cerchio et al. (2014) note that the response of reduced singing has implications on the breeding display (and potentially upon breeding success) of humpbacks, it would be highly speculative to assume that this species behavior is not altered by seismic survey noise outside of the breeding season. There is no known information regarding response of humpback whales to seismic survey noise on their summer feeding grounds. However, we note the Level A exposure of a humpback whale or possibly a humpback mother and calf pair to Apache’s seismic survey efforts in 2014, and the anecdotal report of a humpback that appeared to be stranded in Turnagain arm shortly after that Level A exposure occurred. While humpbacks do not regularly occur throughout upper Cook Inlet, they are far more likely to co-occur with seismic survey efforts towards the southern portions of the action area where the 3D seismic surveys will take place.

Fin whales are highly vocal whales that produce loud vocalizations for long periods of time (Section 4.1.2). Nieukirk et al. (2012) recorded multiple sources of airguns simultaneously resulting in high levels of noise masking biological sounds, including fin whale calls (Nieukirk et al. 2012). Both McDonald et al. (1993) and Nieukirk et al. (2004) reported fin whales continued calling during seismic activity; however, Nieukirk et al. (2004) documented loud whale vocalizations were detected during intense airgun activity. Although these studies recorded the fin whale continued calling during seismic activity, it is likely seismic noise may decreases the effective range of fin whale communication (Nieukirk et al. 2012).

<u>Hearing in Fin and Humpback Whales –</u> As is the case for all baleen whales, direct data on fin and humpback and whale hearing sensitivity are not available. However, the applied frequency range is between 7 Hz to 35 kHz (Table 14.). Sounds produced by airgun arrays are broadband, with most energy below 1 kHz (Arctic Slope Regional Corporation 2014). Therefore, fin and

humpback whales would certainly be able to hear a portion of the energy produced by the airgun arrays. However, available information does not allow us to conclude what portion of that energy may fall within the most sensitive portion of the whale's hearing range.

Steller Sea Lions

While there are no published data on seismic effect on sea lions, anecdotal data and data on arctic seals indicate that sea lions and other pinnipeds generally tolerate strong noise pulses (Richardson et al. 1995). Monitoring studies in the Alaskan and Canadian Beaufort Seas during 1996–2002 provided considerable information regarding behavior of arctic seals exposed to seismic pulses (Harris et al. 2001, Moulton and Lawson 2002, Miller et al. 2005). These seismic projects usually involved arrays of 6 to 16 with as many as 24 airguns with total volumes of 560 to 1500 cui. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings tended to be farther away from the seismic vessel when the airguns were operating than when they were not (Moulton and Lawson 2002). However, these avoidance movements were relatively small, on the order of 100 m (328 ft) to (at most) a few hundred meters, and many seals remained within 100 to 200 m (328 to 656 ft) of the trackline as the operating airgun array passed by them. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997. Miller et al. (2005) also reported higher sighting rates during non-seismic than during line seismic operations, but there was no difference for mean sighting distances during the two conditions. The operation of the airgun array had minor and variable effects on the behavior of seals visible at the surface within a few hundred meters of the array. 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 more likely to swim towards or parallel to the vessel during non-seismic periods. No consistent relationship was observed between exposure to airgun noise and proportions of seals engaged in other recognizable behaviors, e.g. "looked" and "dove." Such a relationship might have occurred if seals seek 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).

Hearing Impairment in Steller Sea Lions – The auditory response for pinnipeds to underwater pulsed sounds has been examined in only one study. Finneran et al. (2003) 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 1μPa2s). The 2012 Apache seismic monitoring program observed four Steller sea lions, and only during periods without seismic airgun activity. Therefore, any hearing impairment was unlikely. There was speculation that a large group of unidentified pinnipeds hauled out at the Beluga River may have been Steller sea lions.

Summary of Airgun Noise Effects

Both 2D and 3D seismic activity are only scheduled for one season; that is, 3D will occur during either 2019 or 2020 and 2D will occur during either 2021 or 2022 (Table 1). Although both 2D and 3D seismic activity are scheduled from April through October, each activity is only scheduled for a total of 10 and 60 days, respectively. Only 2 hr per day of seismic activity will occur during 2D seismic surveys. 3D seismic surveys are scheduled to continue 24 hr per day with approximately 15-17 hr of active airgun activity per day; however, as the seismic vessel turns around to prepare for the next transect, there is a 1.5 hr break in seismic activity. Due to the overall short-term duration of seismic activity (i.e., one season), if ESA-listed species avoid areas where seismic activity is taking place, they will likely return once the activity has ceased.

Beluga whales will likely be more affected by the 2D seismic surveys than the 3D seismic surveys. The 2D seismic surveys will take place along the Kenai Peninsula from the Kasilof River south to Anchor Point (Section 2.1.1). Beluga whales are commonly observed nearshore and will likely be more affected by the noise associated with the 2D than the 3D seismic surveys for that reason. Belugas could be affected by the noise associated with 2D seismic surveys while at the mouth of the Kasilof River or traveling along the shore of the Kenai Peninsula. The noise associated with 3D seismic surveys is less likely to affect belugas because the OCS blocks are located offshore where beluga whales have been less frequently found.

A small portion of the 2D seismic survey is located within beluga whale Critical Habitat 2 (Figure 17), while the 3D seismic surveys do not overlap with beluga whale critical habitat. To reduce impacts from the 2D seismic activity on belugas in the portion of the Critical Habitat 2 that overlaps with the 2D seismic surveys, Hilcorp will not begin activity in the northern portion of the project area near the Kasilof River before June (Section 2.1.2). In addition, the seismic program is not scheduled to occur in the upper Cook Inlet where Critical Habitat 1 and most of Critical Habitat Area 2 is located. Upper Cook Inlet is an important beluga whale feeding and concentration area during the summer, when more than 95 percent of the whale population is concentrated in this limited portion of its range.

Seismic surveys will likely have a greater impact on fin and humpback whales than other activities planned by Hilcorp because fin and humpback whales are more likely present offshore near the 3D seismic portion of the project area than any other activity. Based upon information regarding baleen whale disturbance reactions to seismic activity, some baleen whales may exhibit minor, short-term disturbance responses to underwater sounds from seismic activities. Any potential impacts on fin and humpback whales' behavior would be localized within the action area and would not result in population-level effects. Hilcorp will implement mitigation measures to reduce impacts to fin and humpback whales (Section 2.1.2).

As with fin and humpback whales, seismic surveys will likely have a greater impact on Steller sea lions than any other activity planned by Hilcorp because Steller sea lions are more commonly found in lower Cook Inlet than in middle or upper Cook Inlet. Although rookeries and haul-outs are found within the action area, no rookeries or haul-outs are found in or adjacent to the area where the 2D or 3D seismic surveys will take place. Hilcorp will implement mitigation measures to reduce impacts to Steller sea lions (Section 2.1.2).

Behavioral responses by ESA-listed species, such as avoidance, will likely be the most common response observed during seismic activity. There is no direct evidence that noise from Cook Inlet seismic exploration activity has caused physical injury, death, or stranding to any marine mammal. However, evidence suggests a possible injury and stranding of a humpback whale resulting from 2012 seismic activities in Cook Inlet (NMFS unpublished data). In addition, the proposed seismic activity will be short term and localized and is not located near areas of critical importance to belugas or Steller sea lions during spring, summer and fall. Furthermore, Hilcorp will implement mitigation measures to reduce effects from noise associated with the seismic surveys.

6.2.1.4 Geohazard and Geotechnical Surveys

Hilcorp Alaska plans to collect geohazard and geotechnical survey data in the Federal OCS waters in lower Cook Inlet in 2019 or 2020 after the 3D seismic survey and before drilling the exploratory wells, in the Trading Bay area in 2019 or 2020 prior to drilling the exploratory wells, and to locate the discovery well in the North Cook Inlet Unit in 2020 (Section 2.1.1). The typical survey duration in each location is approximately 30 days. The surveys are conducted from a single support vessel. Equipment used during a typical geohazard and geotechnical surveys consists of single beam and multi-beam echosounders, side scan sonar, sub-bottom profilers, and magnetometers. In addition to geohazard and geotechnical surveys, sub-bottom profilers will be used during pipeline inspections to obtain images of the seabed along and immediately adjacent to all subsea pipelines (Section 2.1.1). The single beam and multi-beam echosounders and side scan sonar produce sounds above 200 kHz. We do not consider sounds over 200 kHz to be harmful to marine mammals because the frequency is well above the hearing range of ESA-listed marine mammals in the project vicinity. Therefore, sub-bottom profilers (frequency range 1 to 24 kHz; Table 34) are the only geohazard and geotechnical survey equipment that emitted sound that could cause Level A and B acoustic harassment of marine mammals, and therefore, are discussed below. Magnetometers passively measure changes in magnetic fields over the seabed, and therefore, will not affect marine mammals. Section 6.2.2.7 discusses other geohazard and geotechnical survey equipment (i.e., single beam and multi-beam echosounders and side scan sonar, magnetometers) Hilcorp plans to use that are not anticipated to cause Level A and B acoustic harassment.

High and low resolution sub-bottom profilers will be used during geohazard and geotechnical surveys (Table 34). The proposed high-resolution sub-bottom profiler operates at source level of 210 dB re 1 μPa rms at 1 m. The proposed system emits energy in the frequency bands of 2 to 24 kHz. The beam width is 15 to 24 degrees. Typical pulse rate is between 3 and 10 Hz. The secondary low-resolution sub-bottom profiler will be utilized as necessary to increase sub-bottom profile penetration. The proposed system emits energy in the frequency bands of 1 to 4 kHz.

Table 34. Characteristics of sub-bottom profilers.

Equipment	Model (or similar)	Source Level	Frequency
High resolution sub-bottom profiler	Edgetech 3200	210 dB re 1 μPa at 1 m	2-24 kHz
Low resolution sub-bottom profiler	Applied Acoustics AA251	212 dB re 1 μPa at 1 m	1-4 kHz

Beluga Whales

Both the high- and low-resolution sub-bottom profilers produce sounds that could mask significant portions of the frequency window used by belugas to communicate (Table 34). Beluga auditory bandwidth spans from about 0.04-150 kHz (Au 2000). 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), and use echolocation signals (biosonar) with peak frequencies at 40 to 120 kHz (Au 1993). The frequency range between the high- and low-resolution sub-bottom profilers proposed for this project operating at frequencies of 2 to 24 kHz and 1 to 4 kHz, respectively, overlap almost entirely with the communication frequency band of belugas and are almost entirely within their auditory range. For this reason, the sub-bottom profilers may adversely affect beluga communication.

The behavioral response of marine mammals to the operation of the sub-bottom profilers is expected to be similar to that of the airgun (Section 6.2.1.3). Researchers have noted behavioral changes in captive beluga whales and other odontocetes when exposed to very loud impulsive sound similar to seismic airguns (Finneran et al. 2000, Finneran et al. 2002). During field observations in the Beaufort Sea, Miller et al. (2005) reported evidence of belugas avoiding large array seismic operations. Further, Romano et al. (2004) found that a captive beluga whale exposed to airgun sounds produced stress hormones with increasing sound pressure levels, and some hormone levels remained high as long as an hour after exposure (but these hormone levels were far less than those produced during beluga whale chase and capture events).

Although the above observations occurred during beluga exposure to sound pressure levels above those produced by the sub-bottom profilers proposed for the current project, they demonstrate that belugas are susceptible to sound-induced stress and may be behaviorally and physiologically disturbed by loud noises, potentially leading to restricted use of available habitat when such sounds are produced. Therefore, Cook Inlet belugas may experience negative effects resulting from the operation of sub-bottom profilers in zones exceeding 160 dB re1 μPa.

TTS may occur if a beluga is within the Level B harassment zone; however, as described in the *Threshold Shift* section, the severity of TTS depends on the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt 2013). If a beluga should experience TTS from noise associated with sub-bottom profilers, a full recovery would be expected within a few days of exposure because of the short-term nature of this condition.

There is a very low probability of Level A harassment, serious injury, or mortality to beluga whales as well as humpback whales, fin whales, and Steller sea lions from noise associated with the geohazard and geotechnical surveys. Mitigation measures will further reduce impacts from geohazard and geotechnical surveys and the likelihood of a Level A harassment.

Humpback Whales, Fin Whales and Steller Sea Lion

The operating frequencies for the high- and low-resolution sub-bottom profilers is 2 to 24 kHz and 1 to 4 kHz, respectively, are likely within the upper hearing ranges of humpback and fin whales (7 Hz to 35 kHz) and Steller sea lions (60 Hz and 39 kHz), and therefore, will likely mask sounds overlapping those frequencies. As with beluga whales, behavioral and physiological responses of humpback whales, fin whales and Steller sea lions to the operation of the sub-bottom profilers is expected to be similar to that of the airgun (Section 6.2.1.3), resulting in short-term avoidance or displacement from the area in which the geohazard and geotechnical surveys will take place. Additionally, TTS may occur if a humpback whale, fin whale or Steller sea lion is within the Level B harassment zone; however, the severity of TTS depends on the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt 2013). If an animal should experience TTS from noise associated with sub-bottom profilers, a full recovery would be expected within a few days of exposure because of the short-term nature of this condition. The operations of the sub-bottom profiler in the OCS blocks in lower Cook Inlet will likely have a greater effect on humpback whales, fin whales and Steller sea lions than the surveys conducted in Trading Bay area or at the North Cook Inlet Unit located in middle Cook Inlet because these ESA-listed species are found in higher densities in lower Cook Inlet than in middle Cook Inlet.

6.2.1.5 Pipe Driving, Conductor Installation and Vibratory Sheet Pile driving

During exploratory drilling, pipe driving activity will be required for the 2-4 exploratory wells in the Federal OCS waters in lower Cook Inlet in 2020 to 2022, and 1-2 exploratory wells in the Trading Bay area in 2020. Pipe driving will take approximately 3 days per well. Pipe driving is the acoustic source associated with drilling and P&A activities that may cause Level A or B acoustic harassment (Section 2.1.1). Other sound sources associated with exploratory drilling that are not expected to cause Level A or B acoustic harassment are described in Section 6.2.2.

Hilcorp plans to construct a rock causeway as part of the Iniskin Peninsula exploration program (Section 2.1.1). The construction of a rock causeway with a dock face comprised of sheet piles will occur adjacent to the Fitz Creek staging area to improve accessibility of the barge landing during construction and drilling operations (Section 2.1.1). The sound source associated with the construction of the causeway that may cause Level A or B acoustic harassment is vibratory sheet pile driving. Rock placement of the causeway is not expected to cause Level A or B acoustic harassment, and therefore, is discussed in Section 6.2.2.3.

Pipe Driving and Conductor Installation – Drive pipes are installed using impact pile driving techniques (Section 2.1.1). Illingworth and Rodkin (2014) measured sound source levels at 195 dB at 55 m during drive pipe hammering operations from the rig *Endeavour* for Buccaneer in 2013, with underwater levels exceeding 160 dB rms threshold at 1.63 km (1 mi). Conductors are slightly smaller diameter pipes than the drive pipes used to transport or "conduct" drill cuttings to the surface. For these wells, a 50.8-cm (20-in) conductor pipe may be drilled, not hammered, inside the drive pipe, dependent on the integrity of surface formations, and therefore, no noise concerns are associated with the conductor pipe drilling.

Vibratory Sheet Pile Driving – Vibratory pile drivers use a system of counter-rotating eccentric weights to transmit vertical vibrations into the pile. These vibrations "liquefy" the contacted sediments, allowing easy gravitational sinking into the sediment bed, facilitated by the heavy-weighted hammer. The dock face on the rock causeway will be comprises of sheet piles which will be installed using a vibratory hammer. Illingworth and Rodkin (2007) compiled measured near-source (10 m [32.8 ft]) SPL data from vibratory pile driving for different pile sizes ranging in diameter from 30.5 to 243.8 cm (12 to 96 in). Sound source levels for 61.0-cm (24-in) AZ steel sheet piles, similar to what will be used for the dock face of the rock causeway on the Iniskin Peninsula, were measured at 160 dB at 10 m with a distance threshold of around 4.6 km (2.9 mi) (Illingworth and Rodkin 2007).

Effects from Pipe Driving and Vibratory Sheet Pile Driving Noise

Studies on behavioral responses of cetaceans and pinnipeds in the presence of pile driving are limited (Würsig et al. 2000, Blackwell et al. 2004, Carstensen et al. 2006, Tougaard et al. 2009, Brandt et al. 2011, Dähne et al. 2013, Wang et al. 2014, Kendall and Cornick 2015). Data indicate noise from pile driving can be detected at distances of up to 70 km (Southall et al. 2007b, Bailey et al. 2010). General responses of cetaceans from noise associated with pile driving include, but are not limited to, change in vocal behavior and avoidance of the area.

Beluga Whales

The combined data for mid-frequency cetaceans 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. 2007b). In certain conditions, multiple pulses at relatively low received levels (~80 to 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 individuals either in the field or the laboratory (Southall et al. 2007b).

As discussed in the *Status of the Species* section (Section 4.1.1), 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 2016b). 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 to 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 to 75 kHz.

Few studies conducted in upper Cook Inlet documented beluga whale responses to pile driving activity (Kendall and Cornick 2015, Castellote et al. 2018). A study conducted during the Port of Anchorage Marine Terminal Redevelopment Project in Knik Arm of Cook Inlet, detected 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. 2014). 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. Kendall and Cornick (2015) visually observed beluga whales before and during pile driving activity at the MTR Project. They observed a decrease in sighting duration, an increase in traveling relative to other observed behaviors and a change in group composition during pile driving activity. Castellote et al. (2018) indicated masking of beluga vocalizations likely occurs during pile driving activity; however, communication may occur between strikes.

also suggested that vibratory pile driving noise may not adversely affect clicks produced by the Indo-Pacific humpbacked dolphin; however, whistles produced by these dolphins are likely susceptible to auditory masking during vibratory pile driving. Paiva et al. (2015) documented that the number of Indo-Pacific bottlenose dolphins transiting through the Inner Harbour of Port Fremantle, Western Australia during either impact or vibratory pile driving activity was greater when no pile driving activity occurred.

This information leads us to conclude that beluga whales exposed to sounds produced by pile driving operations are likely to respond.

Of the beluga whales that may occur within the Level B harassment zone of pile driving, some whales 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) exposures would occur at received levels >160 (impulsive pipe driving) or > 120 (non-impulsive vibratory sheet pile driving) due to avoidance of high received levels, and shut down mitigation measures (Section 2.1.2).

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 pile driving stressors resulting from their exposure during previous projects; that experience will make some whales more likely to avoid the pipe driving or vibratory pile driving 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 pipe driving or vibratory pile driving activities and encounter another activity in the project area while they are engaged in avoidance behavior.

TTS may occur if a beluga is within the Level B harassment zone; however, as described in the *Threshold Shift* section, the severity of TTS depends on the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt 2013). If a beluga should experience TTS from noise associated with pipe driving or vibratory sheet pile driving activities, a full recovery would be expected within a few days of exposure because of the short-term nature of this condition.

Humpback and Fin Whales

As discussed in Section 6.2.1.3, baleen whales have shown strong overt reactions to impulsive noises, such as seismic operations, at received levels between 160 and 173 dB re 1 μPa rms (Richardson et al. 1986, Ljungblad et al. 1988, McCauley et al. 2000, Miller et al. 2005, Gailey et al. 2007). In addition, baleen whales often detour around drilling activity when received levels are as low as 119 dB re 1 μPa rms (Malme et al. 1983, Richardson et al. 1986). Therefore, both fin and humpback whales may be less tolerant of vibratory sheet pile driving activity than the pipe driving activity. However, vibratory sheet pile driving will take place off the Iniskin Peninsula where both species are not likely found. Both pipe driving and vibratory sheet pile driving are within the hearing range of fin and humpback whales (7 Hz to 35 kHz), and these whales will likely hear the noise associated with these activities at great distances. TTS may occur if a humpback or fin whale is within the Level B harassment zone. If a humpback or fin whale should experience TTS from noise associated with pipe driving or vibratory sheet pile driving activities, a full recovery would be expected within a few days of exposure because of the short-term nature of this condition. Refer to the *Threshold Shift* section for more detail on TTS.

Fin and humpback whales are more frequently observed in lower Cook Inlet where both activities will take place. Therefore, we expect that these activities will likely disturb some individuals of these species. Anticipated responses to these pipe driving and vibratory sheet pile driving could be avoidance of the area where the activities are occurring and possibly change in vocal behavior. However, to reduce impacts to fin and humpback whales, Hilcorp will implement mitigation measures (Section 2.1.2).

Steller Sea Lions

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 2018a).

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).

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 (Section 4.1.4; (Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a)). Sighting of Steller sea lions in the middle and upper areas of Cook Inlet are rare and not well documented (Jacobs Engineering 2017). During the early part of the open-water season, Steller sea lions are occupying rookeries during their pupping and breeding season (late May to early July). Although rookeries and haul-outs exist in the action area (Figure 24), no rookeries or haul-outs occur in the immediate project area where noise from pipe driving or vibratory sheet pile driving could cause harassment. Noise associated with pipe driving or vibratory sheet pile driving is unlikely to disturb Steller sea lions at rookeries and haul-outs because by the time the noise reaches these sites, sound will likely have attenuated to levels not likely to cause disturbance. However, it is possible that individual or groups of Steller sea lion could be observed during drilling exploration near the pipe driving activity taking place at the OCS blocks or Trading Bay Unit. Steller sea lions may also be observed near the vibratory sheet pile driving activity taking place off of the Inskin Peninsula.

Of the Steller sea lions that may occur within the Level B harassment zone of pipe driving or vibratory sheet pile driving activities, 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 temporary and pinnipeds seem rather tolerant of low frequency noise. TTS may occur if a Steller sea lion is within the Level B harassment zone. If a Steller sea lion should experience TTS from noise associated with pipe driving or vibratory sheet pile driving activities, a full recovery would be expected within a few days of exposure because of the short-term nature of this condition (see *Threshold Shift* section). We anticipate that few (if any) exposures would occur at received levels >160 (impulsive pipe driving) or > 120 dB (non-impulsive vibratory sheet pile driving) due to avoidance of high received levels, and shut down mitigation measures.

6.2.1.6 <u>Water Jets</u>

Routine maintenance includes the use of water jets during activities such as subsea pipeline inspections, stabilizations, and repairs; platform leg inspections and repairs; and anode sled installations and/or replacement (Section 2.1.1). The use of water jets for maintenance will occur on an annual basis from 2019 to 2024. Water jets may result in Level A or B acoustic harassment. A water jet is a zero-thrust water compressor that is used for underwater removal of marine growth or rock debris underneath the pipeline. The system operates through a mobile pump, which draws water from the location of the work. Water jets that will likely be used in Cook Inlet include, but are not limited to, the CaviDyne CaviBlaster® and the Gardner Denver Liqua-Blaster. Noise generated during the use of the water jets would be very short in duration (30 minutes or less at any given time) and episodic.

Hilcorp Alaska conducted underwater measurements during 13 minutes of CaviBlaster® use in Cook Inlet in April 2017 (Austin 2017). Received sound levels were measured up to 143 dB re 1 µPa rms at 170 m and up to 127 dB re 1 µPa rms at 1,100 m. Sounds from the Caviblaster® were clearly detectable out to the maximum measurement range of 1.1 km. Using the measured transmission loss of 19.5 log R, the source level for the Caviblaster® was estimated as 176 dB re 1 µPa at 1 m yielding a 120 dB distance threshold of 860 m. The sounds were broadband in nature, concentrated above 500 Hz with a dominant tone near 2 kHz. The measured sound source levels for the water jet were used to estimate Level A and B acoustic harassment.

Cook Inlet Beluga Whales, Humpback Whales, Fin Whales, and Steller Sea Lions

Water jets are only expected to be used for a short period of time, approximately 30 minutes per day for about 3 days per month, and therefore, not likely to have a great effect on ESA-listed species. No published data on marine mammal responses to noise associated with water jets (stationary non-impulsive sound) exist; however, the noise associated with water jets is detectable by and has the potential to harass marine mammals. Water jets produce noise between 0.5 kHz to 2 kHz, within the hearing ranges for the Cook Inlet beluga whales, fin whales, Mexico DPS humpback whales, Western North Pacific DPS Humpback whales, and western DPS Steller sea lions, and therefore, masking of important sounds for ESA-listed species could occur. However, masking only exists for the duration of time when water jets sound is emitted and would be short-term (30 minutes or less at any given time) and episodic.

Out of all the ESA-listed species, beluga whales will more likely be affected by noise associated with water jets because water jet activity will take place in middle Cook Inlet where belugas are more common than other whales; however, the effects will likely be minimal do to the short duration in activity. Fin whales, humpback whales and Steller sea lions are not frequently found in middle Cook Inlet where water jet activity will take place, and therefore, will not likely be greatly affected by noise from this activity. Hilcorp Alaska will implement mitigation and monitoring measure to reduce the potential impacts to ESA-listed species, such as an EZ and SZ (Section 2.1.2).

6.2.1.7 Summary

While each activity may result in underwater noise and potential disturbance to marine mammals and the effects are evaluated in this opinion, not all of the activities are expected to exceed the Level A and B acoustic harassment criteria, and therefore, are not evaluated in estimating exposures. Only those specific activities identified in this section as exceeding MMPA take criteria were evaluated for potential Level A and B take. Activities exceeding the Level A and B take criteria that were used to estimate ESA take include 2D and 3D seismic surveys, vertical seismic profilers, sub-bottom profilers used in geohazard surveys (i.e., high- and low-resolution), drive pipe installation, vibratory sheet pile driving, and water jets used during routine maintenance. For purposes of our analysis, we are considering any anticipated take under the MMPA to be expected take under the ESA.

6.2.2 Acoustic Sources Not Likely to Adversely Affect Listed Species or Critical Habitat

Other sound sources associated with Hilcorp Alaska's oil and gas activities in Cook Inlet that may cause disturbance, but were not used to estimate Level A or B acoustic harassment are discussed in this section. Table 35 summaries these sound source and the following text describe their effects on ESA-listed species.

Table 35. Summary of other noise sources associated with the Hilcorp Cook Inlet oil and gas program.

Activity	Sound Pressure Levels (dB re 1 µPa)	Frequency	Reference
Geohazard Surveys	210-220 dB rms at 1 m	Echosounders Side scan sonar: >200 kHz	Manufacturer specifications
Exploratory drilling rig	137 dB rms at 1 m	<200 Hz	Marine Acoustics Inc. 2011
Tugs under load towing rig	167 dB rms 1 at m	<500 Hz	Austin et al. 2013
Drilling and well construction: Drilling Mud pumping	158 dB rms at 1 m 148.8 dB rms at 1 m	<500 Hz	Denes and Austin 2016
Rock laying for Iniskin causeway	Less than dredging: 136-141 dB rms at 12-19 m	<500 Hz	Nedwell and Edwards 2004; URS 2007
Offshore production platforms	97-111 dB rms at 0.3-19 km	<500 Hz	Blackwell and Greene 2003
Hydraulic grinder	159 dB rms at 1 m	<1 kHz	Stanley 2014
Underwater cutter: Diamond wire saw Hydraulically-powered Guillotine saw	136.1-141.4 dB rms at 10 m; 148 dB rms at 1 m		
Drones	100 dB rms at 1 m	<500 Hz	Christiansen et al. 2016
Pingers	192 dB rms at 1 m	4-14 kHz	Manufacturer specifications
General vessel operations	145-175 dB rms at 1 m	10 Hz – 1,500 Hz	Richardson et al. 1995; Blackwell and Greene 2003; Ireland and Bisson 2016
General aircraft operations	100-124 dB rms at 1 m	<500 Hz	Richardson et al. 1995

6.2.2.7 Geohazard and Geotechnical Surveys

As discussed in Section 6.2.1.4, Hilcorp will conduct geohazard and geotechnical surveys once seismic activity is completed and prior to exploration drilling or P&A activities (Section 2.1.1). In addition to sub-bottom profilers (Section 6.2.1.4), single-beam and multibeam echosounders, side scan sonar and magnetometers may be used (Table 36).

Echosounders – The proposed multi-beam echosounder operates at source level of a maximum of 220 dB re 1 μPa rms at 1 m. The multibeam echosounder emits high frequency (240 kHz) energy in a fan-shaped pattern of equidistant or equiangular beam spacing. The beam width of the emitted sound energy in the along-track direction is 1.5 degrees, while the across track beam width is 1.8 degrees. The maximum ping rate of the multibeam echosounder is 40 Hz.

The proposed single-beam echosounder operates at source level of approximately 220 dB re 1 μPa rms at 1 m. The transducer selected uses a frequency of 210 kHz and has a ping rate of up to 20 Hz. The transducer's beam width is approximately 3 degrees.

Side Scan Sonar – The proposed side scan sonar system will operate at about 400 kHz and 900 kHz. The source level is 215 dB re 1μPa rms at 1 m. The sound energy is emitted in a narrow fan-shaped pattern, with a horizontal beamwidth of 0.45 degrees for 400 kHz and 0.25 degrees at 900 kHz, with a vertical beam width of 50 degrees. The maximum ping rate is 75 Hz.

Magnetometer – A marine magnetometer will be used for the detection of magnetic deflection generated by geologic features and buried or exposed ferrous objects which may be related to archaeological artifacts or modern man-made debris. The magnetometer will be towed at a sufficient distance behind the vessel to avoid data pollution by the vessel's magnetic properties. Magnetometers passively measure changes in magnetic fields over the seabed and do not impact marine mammals.

Table 36. Acoustic characteristics of geohazard sources.

Equipment	Model (or similar)	Source Level	Frequency
Single beam echosounder	Odom SMBB200	220 dB re 1 μPa at 1 m	210 kHz
Multi-beam echosounder	Reson 7101	220 dB re 1 μPa at 1 m	240 kHz
Side scan sonar	Edgetech 4125	215 dB re 1 μPa at 1 m	400 kHz / 900 kHz

It is extremely unlikely that the acoustic devices with operating frequencies above 200 kHz (i.e., side scan sonar, single-beam echosounder, and multi-beam echosounder) will affect the ESA-listed species considered in this opinion because these frequencies are above the assumed hearing ranges of baleen whales, including fin and humpback (i.e., between 7 Hz and 25 kHz), beluga whales (i.e., 150 Hz to 160 kHz), and sea lions (i.e., between 60 Hz to 39 kHz). In the unlikely event that these acoustic devices operating above 200 kHz are audible to ESA-listed species, it is unlikely that the pulsed sounds produced by these devices will reach these species because the sounds are produced in narrow beams and attenuate rapidly. To hear such sounds, ESA-listed species would need to be within a few meters of the source and within the narrow beam of sound (i.e., directly under the vessel), which is extremely unlikely.

For these reasons (i.e., inaudibility and spatially limited exposure area), we conclude that effects from side scan sonar, single-beam and multi-beam echosounders to Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are extremely unlikely to occur, and are therefore discountable.

6.2.2.2 Exploratory Drilling

Hilcorp Alaska plans to drill 2 to 4 exploratory wells in the Federal OCS waters in lower Cook Inlet starting in 2020, 1 to 2 exploratory wells in the Trading Bay area in 2020, development drilling at the Granite Point Platform, and conduct P&A activities in North Cook Inlet Unit in 2020 (Section 2.1.1). Each exploratory well in both lower Cook Inlet and Trading Bay area will take approximately 40 to 60 days to drill and test. Each development well at the Granite Point Platform will take approximately 40 to 60 days to drill and test and convert to production if applicable. P&A activities will take 60 to 90 days to complete on the North Cook Inlet Unit. Acoustic sources associated with drilling and P&A activities, in addition to pipe driving and VSP (Section 6.2.1) include the exploratory drilling rig or jack-up rig, mobilization of the rig (tugs towing the rig), drilling and well construction. Helicopter and vessel will also operate during exploratory drilling; however, they are discussed in Sections 6.2.2.8 and 6.2.2.9.

Exploratory Drilling Rig – Hilcorp Alaska proposes to conduct its exploratory drilling, development drilling and P&A activities using a jack-up rig similar to the *Spartan 151* drill rig (Section 2.1.1). Furie Operating Alaska, LLC (Furie) performed detailed underwater acoustic measurements in the vicinity of the *Spartan 151* in 2011 (Marine Acoustics Inc. 2011) northeast of Nikiski Bay in water depths of 24.4 to 27.4 m (80 to 90 ft). Primary sources of rig-based acoustic energy were identified as coming from the D399/D398 diesel engines, the PZ-10 mud pump, ventilation fans (and associated exhaust), and electrical generators. The source level of one of the strongest acoustic sources, the diesel engines, was estimated to be 137 dB re 1 µPa rms at 1 m in the 141 to 178 Hz bandwidth. Based on this measured level, the 120 dB rms acoustic received level isopleth would be 50 m (154 ft) away from where the energy enters the water (jack-up leg or drill riser).

Effects from the exploratory drill rig on ESA-listed species would be expected to be similar to those of an offshore production platform (Section 6.2.2.4). Once the drilling rig is in place, it is stationary. Noise associated with the drill rig originates from the machinery located on deck of the platform well above the water. It is expected that once noise from the platform enters the water is it relatively weak because of the small surface area in contact with the water (Blackwell and Greene 2002), that is the jack-up legs or drill risers. Furthermore, the acoustic received level isopleth is relatively small, 50 m (154 ft) away from where the energy enters the water (i.e., jack-up leg or drill riser). It is likely ESA-listed species would exhibit minor responses such as low-level avoidance behavior and short-term vigilance if they are near the exploratory drilling rig, with inconsequential effects. Considering these factors, we conclude that the adverse effects from noise associated with the drill rig on Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are insignificant.

Rig Mobilization (Tugs Towing a Rig) – Depending on the rig selection and location, the drilling jack-up rig will be towed on site using up to three ocean-going tugs licensed to operate in Cook Inlet. Vessel speed during the rig tow is generally less than 5 knots. Three tugs are needed to maintain control and precisely position the rig at the drill site. The exact tugs or staging location for the tugs are not known at this time but will be similar to what has been used for previous drilling projects in Alaska.

Shell's drilling activities in 2012 in the Chukchi Sea of the tug *Lauren Foss* towing the *Tuuq* estimated source level at 167 dB at 1 µPa rms at 1 m, with the estimated 120 dB distance threshold of 2,154 m (Austin et al. 2013).

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. The proposed action involves three tugs (likely two actively towing and one for braking/positioning) transporting the drill rig.

In the Canadian Arctic, beluga whales have been observed reacting to noise from ships underway at extremely long distances of 35 to 50 km (Cosens and Dueck 1988, Finley et al. 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. Although belugas may have become habituated to industrial noises 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.

Baleen whale response distances to towing activities are expected to vary, depending on sound-propagation conditions and whether or not the animals are actively feeding. 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 (Ljungblad et al. 1988, Wartzok et al. 1989, Corkeron 1995, Morete et al. 2007). 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. 1989, Richardson et al. 1995, Heide-Jørgensen et al. 2003). Considering that tugs towing the drill rig are only anticipated to travel at ~ 5knots, we do not anticipate consequential reactions to towing noise.

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. Repeated disturbances that result in abandonment or reduced use of rookeries by lactating females could negatively affect body condition and survival of pups through interruption of normal nursing cycles (NMFS 2008c). Pups are the age-class most vulnerable to disturbance from vessel traffic (NMFS 2008c).

We anticipate that noise associated with towing the drill rig would drop to the 120 dB isopleth within 2,154 meters (or less) of the active tugs. At these distances, a whale or pinniped 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. For this reason, and with the implementation of mitigation measures described in Section 2.1.2, we conclude that the adverse effects from tugs towing the drilling rig on Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are insignificant. Further discussion on ESA-listed species responses to vessels is found in Section 6.2.2.8.

Drilling and Well Construction – Hilcorp is planning drilling and well construction in the Federal OCS waters in lower Cook Inlet, in the Trading Bay area in, and at the Granite Point Platform (Section 2.1.1). Denes and Austin (2016) measured sound source levels for drilling (158 dB rms at 1 m; transmission loss coefficient of 15.1) and mud pumping (148.4 dB rms at 1 m; transmission loss coefficient of 12.1) from the Yost jack-up rig, producing 120 dB isopleths of 330 and 225 m, respectively. Denes and Austin (2016) found the acoustic energy of drilling noise was predominantly under 500 Hz. Denes and Austin (2016) did not record other rig-based activities including cementing, running casing, and tripping in and out of the hole with drill string; however, these activities may also produce sounds similar to mud pumping. The sound source levels from drilling and well construction was not used to estimate Level A or B acoustic harassment.

Drilling and well construction sounds are similar to vessel sounds in that they are relatively low-level and low-frequency. Since the rig is stationary in a location with low marine mammal density, the impact of drilling and well construction sounds produced from the jack up rig is expected to be lower than a typical large vessel. There is open water in all directions from the drilling location. Any marine mammal approaching the rig would be fully aware of its presence long before approaching or entering the zone of influence for behavioral harassment, and we are unaware of any specifically important habitat features (e.g., concentrations of prey or refuge from predators) within the rig's zone of influence that would encourage marine mammal use and exposure to higher levels of noise closer to the source. Given the absence of any activity-, location-, or species-specific circumstances or other contextual factors that would increase concern, we do not expect routine drilling noise to result in the take of marine mammals.

Hilcorp will also monitor a 500 m (1,640 ft) zone and ensure it is clear of marine mammals prior to commencing drilling or other well construction activities to avoid startling a marine mammal nearby. Drilling sound is naturally "ramped up" from an initial low rotation pressure, and this continuous sound source is unlikely to startle an approaching animal. The impact of drilling noise (above 120 dB) is very minor, and thus adverse effects to Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions will be immeasurably small. Therefore, we conclude that the adverse effects from drilling noise and well construction activities on these species are insignificant.

6.2.2.3 Iniskin Peninsula Exploration Project

Rock Laying – The construction of an intertidal rock causeway is proposed adjacent to the Fitz Creek staging area to improve the accessibility of the barge landing during construction and drilling operations between 2020 and 2022 (Section 2.1.1). The causeway will extend seaward from the high tide line approximately 366 m (1,200 ft) to a landing area 46 m (150 ft) wide. Measurements of underwater noise during rock placement have shown that the rock placement itself is not distinguishable from the vessel noise (Nedwell and Edwards 2004). Rock placement vessels are similar to dredging vessels. URS (2007) measured underwater sounds levels from clamshell dredging at the Port of Anchorage and report broadband levels of 136 to 141 dB re 1 μPa rms at 12 to 19 m.

Construction and potential removal of the causeway will occur from the shoreline with land-based construction equipment, no in-water equipment will be used (Section 2.1.1). Noise from rock laying is expected to be less than dredging and is not known to generate sound at levels expected to disturb ESA-listed species. If noise associated with rock laying does cause disturbance, it is likely to be minor and include short-term low-level avoidance behavior or temporary increase vigilance.

We do not anticipate noise from the rock laying to cause harassment for ESA-listed species. Individuals or small groups of Steller sea lions may be present nearshore adjacent to causeway project area; however, humpback and fin whales will not likely be in the area (Section 4.1). The causeway is not planned at a known Steller sea lion rockery or haulouts or biologically significant location for humpback and fin whales. The impact of rock laying-associated noise is very minor, and thus the adverse effects to Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions will be immeasurably small. Therefore, we conclude that the adverse effects from this stressor are insignificant.

The causeway is located in Cook Inlet beluga whale critical habitat area 2. As discussed in Section 4.1.1, critical habitat area 2 is known fall and winter foraging and transit habitat for beluga whales as well as spring and summer habitat for smaller concentrations of beluga whales. Construction of the causeway is planned between the months of April and October. If construction takes place during April and May, small groups of belugas may be present; however, adverse effects to beluga whale from noise associated with rock laying is expected to be minor because belugas are more frequently found in middle to upper Cook Inlet during this time of year. The impact of rock laying-associated noise is very minor, and thus adverse effects to Cook Inlet beluga whales will be immeasurably small. Therefore, we conclude that adverse effects from noise associated with rock laying on Cook Inlet beluga whales are insignificant.

6.2.2.4 Offshore Production Platforms

Whales and pinnipeds have been reported near oil production platforms including gray whales during their migration off the California coast and beluga whales in Cook Inlet. Richardson et al. (1995) suggests that the noise from the platforms are often low, steady and not very disturbing and that stronger reactions from marine mammals would be expected as sound levels increase near the platforms with support vessels or other noisy activities.

As discussed in Section 2.1.1, offshore production platforms have been present in Cook Inlet since 1964; as a result, noise associated with offshore production platforms has existed in the area since then. Hilcorp routinely conducts development drilling activities at offshore platforms and development drilling activities occur from existing platforms within the Cook Inlet through either open well slots or existing wellbores in existing platform legs using conventional drilling equipment from a variety of rig configurations.

For similar reasons as discussed in Section 6.2.2.2 for the exploratory drill rig, it is expected that the effects from noise associated with offshore production platforms would be minor. Offshore production platforms are stationary and the noise associated with them originates from the machinery located on deck of the platform well above the water. It is expected that once noise from the platform enters the water is it relatively weak because of the small surface area in contact with the water (Blackwell and Greene 2002), that is the four legs. Furthermore, sound levels are not expected to exceed acoustic harassment. It is likely ESA-listed species would exhibit minor responses such as low-level avoidance behavior and short-term vigilance. Considering these factors, the impact of noise associated with the offshore production platforms is very minor, and thus adverse effects to Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are immeasurably small. Therefore we conclude that the adverse effects from noise associated with the offshore production platforms are insignificant.

6.2.2.5 Routine Maintenance

Routine maintenance activities include: subsea pipeline inspections, stabilizations, and repairs; platform leg inspections and repairs; and anode sled installations and/or replacement (Section 2.1.1). Hilcorp Alaska's routine maintenance of platforms and pipelines requires the use of dive support vessels, hydraulic grinders, underwater pipe cutter, and drones for inspection and repair of these facilities (Section 2.1.1). Each of these sources emit sound levels that may effect ESA-listed species. Dive support vessels are discussed in Section 6.2.2.8, while hydraulic grinders, underwater pipe cutters, and drones are discussed below.

Hydraulic Grinder – Specifications for the GR 29 Underwater Hydraulic Grinder state that the SPL at the operator's position would be 97 dB in air (Stanley 2014). No underwater measurements are available for the hydraulic grinder; however, using an estimate of converting sound level in dB in air to water by adding 61.5 dB would result in an underwater level of approximately 159 dB[18]. Then, applying the conventional practical spreading equation (with a transmission loss coefficient of 15) yields a 120 dB Level B acoustic harassment threshold distance for non-impulsive sound sources of 250 m. NMFS Permits Division is not authorizing take for this activity. Hilcorp established an EZ or shutdown zone of 250 m[19] (the 120 dB Level

[18] Converting levels in air to water is not a preferred method as reference intensities used to compute sound levels in dB are different in water (1 µPa) and air (20 µPa) and the intensity of a sound wave depends on the density and sound speed of the medium through which the sound is traveling. The result is that sound waves with the same intensities in water and air when measured in watts per square meter have relative intensities that differ by 61.5 dB. This amount must be subtracted from sound levels in water referenced to 1 µPa to obtain the sound levels of sound waves in air referenced to 20 µPa that have the same absolute intensity in watts per square meter. The difference in reference pressures causes 26 dB of the 61.5 dB difference. The differences in densities and sound speeds account for the other 35.5 dB.

[19] The shutdown zone was established in the Letter of Concurence (AK NMFS PCTS # AKR-2017-9687 dated 9/8/17) for Hilcorp's 5-year Maintenance Plan, which they are currenly operating under.

B acoustic harassment threshold distance) to avoid taking ESA-listed species and the SZ of 500 m around the source (Section 2.1.2).

Underwater Pipe Cutter – If necessary, Hilcorp may use an underwater pipe cutter to replace existing pipeline segments in Cook Inlet. The following tools are likely to be used for pipeline cutting activities:

- A diamond wire saw used for remote cutting underwater structures such as pipes and I-Beams. These saws use hydraulic power delivered by a dedicated power source. The saw usually uses a method that pushes the spinning wire through the pipe.
- A hydraulically-powered Guillotine saw which uses an orbital cutting movement similar to traditional power saws.

Generally, sound radiated from the diamond wire cutter is not easily discernible from the background noise during the cutting operation. The Navy measured underwater sound levels when the diamond saw was cutting caissons for replacing piles at an old fuel pier at Naval Base Point Loma (Southwest 2017). They reported an average SPL for a single cutter at 136.1 to 141.4 dB rms at 10 m.

Specifications for the Guillotine saw state that the SPL at the operator's position would be 86 dB in air (Wachs 2014). No underwater measurements are available for hydraulically-powered Guillotine, therefore, using a rough estimate of converting sound level in dB in air to water by adding 61.5 dB would result in an underwater level of approximately 148 dB. The estimated source levels for an underwater pipe cutter does not exceed the acoustic criteria, and therefore was not used to estimate Level A or B acoustic harassment.

No published data on marine mammal responses to noise associated with hydraulic grinders or underwater cutters (stationary non-impulsive sound) exists; however, the noise associated with these equipment are detectable by and may cause disturbance to marine mammals. A hydraulic grinder will be used during this exploration and drilling program for routine maintenance of the underwater pipeline to remove marine growth and rock debris, while the underwater cutter will be used to replace existing pipeline segments. Beluga whales have been observed frequently in the area where these activities will take place, middle Cook Inlet; and therefore will more likely be disturbed during these activities, than humpback whales, fin whales or Steller sea lions. The noise associated with hydraulic grinders and underwater cutters is short-term and episodic. Hilcorp will shutdown the hydraulic grinder if an ESA-listed species appear in or likely to enter the EZ, which will minimize the probably of the animals' exposure to noise at or above the Level B harassment threshold. With the incorporation of the EZ and other mitigation measures (Section 2.1.2), the probability listed marine mammals being exposed to the noise of the hydraulic grinder and underwater pipe cutter above the threshold for Level B harassment or behavioral disturbance occurring is very small, and thus adverse to Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are unlikely to occur. Therefore, we conclude that the adverse effects from noise from the hydraulic grinder and underwater cutter operations on Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are discountable.

6.2.2.6 Drones

Hilcorp may use drones for conducting surveys of structures as part of their routine maintenance activities (Section 2.1.1). Christiansen et al. (2016) recorded in air and underwater noise levels from two small, less than 56 cm (22 in), quadcopter UASs. For airborne levels, the measured frequency was below 500 Hz for both types of UASs and airborne levels were measured around 80 dB re 20 µPa at 1 m (assuming 10 log transmission loss). For underwater levels, the UAS was only detectable above ambient noise levels when flown at 5 or 10 m above the sea surface. The resulting underwater sound levels at those distances above sea surface were 91 to 101 dB rms re 1 µPa at 1 m.

These visual inspections occur on an annual basis for each platform. Generally, the UAS is in the air for 15-20 minutes at a time due to battery capacity, which allows for two legs and part of the underside of the platform to be inspected. The total time to inspect a platform is approximately 1.5 hrs of flight time. The UAS operated at a distance of up to 30.5 m (100 ft) from the platform at an altitude of 9-15 m (30-50 ft) above sea level. To reduce potential harassment of marine mammals, the area around the platform would be inspected prior to launch of the UAS to ensure there are no flights directly above marine mammals. All of the platforms are at least 8 km (5 mi) from shore, so they are not close to any haul out sites for pinnipeds. The sound sources levels for drones does not exceed the acoustic criteria, and therefore, was not used to estimate Level A or B acoustic harassment.

The increase in use of UAS for a variety of purposes has raised an important question on the effects of the UAS on marine mammals (Commission 2016). Most researchers report that, at the altitudes they fly above marine mammals, there is little if any discernible response by the animals (Acevedo-Whitehouse et al. 2010, Goebel et al. 2015, Koski et al. 2015, Moreland et al. 2015). Most studies do not report data on disturbance and generally do not systematically assess the factors affecting disturbance (e.g., vertical and lateral distance, UAS type, engine type, sound levels, speed), as recommended in Smith et al. (2016). In one published study of disturbance, Pomeroy et al. (2015) found that reaction of gray and harbor seals depended on the vertical and lateral distances to the a UAS and may even result in fleeing if the approach of the UAS is very close. Habituation would also affect the threshold at which the sound or proximity of the UAS creates disturbance.

Hilcorp will use UAS on a limited basis and for a short period of time (15 to 20 minutes) for platform leg inspections. Operators will ensure there are no marine mammals prior to takeoff and will increase altitude if a marine mammal surfaces near the UAS. The use of UAS will not be used near any haulout sites. For these reasons, the impacts from drones are very minor, and thus adverse effects to Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions will be immeasurably small. Therefore, we conclude that the adverse effects from drones on Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are insignificant.

6.2.2.7 Pingers

Hilcorp Alaska may deploy moorings for different purposes in Cook Inlet, such as underwater current profilers, bottom-mounted acoustic recorders, or other devices that use a pinger to locate and/or release using a transducer that sends a signal to interrogate the device (Section 2.1.1). Acoustic mooring requiring the use of pingers could occur during the 3D seismic survey (assumed 2-4 moorings), node placement for the 2D seismic survey (used with each node deployment), and potential current profilers deployed each season (assumed 2 to 4 moorings). The signals range from 4 to 14 kHz with source levels typically 192 dB rms at 1 m. Chirps are very short, typically 2 ms, and generally are used for less than a few minutes during the interrogation.

The total amount of time that a pinger is in use per mooring device is less than 10 minutes during deployment and retrieval. To avoid disturbance, the pinger would not be deployed if marine mammals have been observed within 135 m (443 ft) of the vessel (distance to the 160 dB threshold assuming 15 log). Based on the very short duration of pinger use when needed, the implementation of 135 m EZ, and the implementation of mitigation measures (Section 2.1.2), the impacts from the sound produced by the pingers is very minor, and thus adverse effects to Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions will be immeasurably small. Therefore, we conclude that the adverse effects from the sound produced by the pingers on Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are insignificant.

6.2.2.8 Vessel Operations

Vessels of various types and sizes are used to support all the activities include in the scope of this action, specifically for crew and supplies transfer for rigs, platforms, and other maintenance activities (Section 2). The primary underwater noise associated with vessel operations is the continuous cavitation noise produced by the propeller arrangement on the oceanic tugboats, especially when pushing or towing a loaded barge. Other noise sources include onboard diesel generators and the firing rate of the main engine, but both are subordinate to the blade rate harmonics (Gray and Greeley 1980). These continuous sounds for sea going barges have been measured at a peak sound source level of 170 dB re 1 μPa_{rms} at 1 m (broadband), and they are emitted at dominant frequencies of less than 5 kHz, and generally less than 1 kHz (Miles et al. 1987, Richardson et al. 1995).

Coastal barges and tugs produce a peak sound source level of approximately 164 dB re 1 μPa_{rms} at 1 m (Richardson et al. 1995). Crew boats and hovercraft are expected to have smaller peak sound source levels of approximately 156 dB re 1 μPa_{rms} at 1 m (Richardson et al. 1995) and 149 dB re 1 μPa_{rms} at 1 m (Blackwell and Charles R. Greene 2005), respectively. The source level of approximately 170 dB at 1 meter are associated with oceanic tug boat noise and are anticipated to decline to 120 dB re 1μPa rms within 1.85 km (1.15 mi) of the source (Richardson et al. 1995).

Position-keeping in Cook Inlet is a challenge due to the strong currents, so some vessels use dynamic positioning (DP) with bow thrusters when anchoring is not possible. Ireland D.S. and Bisson (2016) measured source levels from 148.5 dB re 1 μPa rms at 1 m at 2,000 Hz to 174.5 dB re 1 μPa rms at 1 m at 10 Hz with 100 percent of all four thrusters.

Vessel noise and presence can impact whales by causing behavioral disturbances, auditory interference, or non-auditory physical and physiological effects (e.g., vessel strike; Section 6.2.4). The distance, speed, and direction of vessel travel in relation to whales, the whales' sensitivity to the vessels, and the activities engaged in by the whales all contribute to the level of response of the whales to the vessels.

Numerous studies of interactions between surface vessels and marine mammals have demonstrated that free-ranging marine mammals engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Goodwin and Cotton 2004, Lusseau 2006). However, several authors suggest that the noise generated during motion is probably an important factor (Evans et al. 1992, Blane and Jaakson 1994, Evans et al. 1994). These studies suggest that the behavioral responses of marine mammals to surface vessels are similar to their behavioral responses to predators.

Based on a suite of studies of cetacean behavior to vessel approaches (Au and Perryman 1982, Hewitt 1985, Bauer and Herman 1986, Corkeron 1995, Bejder et al. 1999, Au and Green 2000, Nowacek et al. 2001, David 2002, Magalhaes et al. 2002, Ng and Leung 2003, Goodwin and Cotton 2004, Bain et al. 2006, Bejder et al. 2006, Lusseau 2006, Richter et al. 2006, Lusseau and Bejder 2007), the set of variables that help determine whether marine mammals are likely to be disturbed by surface vessels include 1) the number of vessels, 2) distance between the animal and the vessel, 3) vessel speed and vector, 4) behavioral state of the animal(s).

Most of the investigations cited earlier reported that animals tended to reduce their visibility at the water's surface and move horizontally away from the source of disturbance or adopt erratic swimming strategies (Williams et al. 2002, Lusseau 2003, 2006). In the process, their dive times increased, vocalizations and jumping were reduced (with the exception of beaked whales), individuals in groups moved closer together, swimming speeds increased, and their direction of travel took them away from the source of disturbance (Kruse 1991, Evans et al. 1994). Some individuals also dove and remained motionless, waiting until the vessel moved past their location. Most animals finding themselves in confined spaces, such as shallow bays, during vessel approaches tended to move towards more open, deeper waters (Kruse 1991). We assume that this movement would give them greater opportunities to avoid or evade vessels as conditions warranted.

Beluga whales

Beluga whale responses to vessels noise varies greatly from tolerance to extreme sensitivity depending on the activity of the whale and previous experience with vessels (Richardson et al. 1995). Beluga whale responses to vessel noise include changes in behavioral states (Richardson et al. 1995), changes in vocalizations (Lesage et al. 1999, Scheifele et al. 2005, Gervaise et al. 2012) and avoidance (Blane and Jaakson 1994, Erbe and Farmer 2000).

In the Canadian high Arctic where vessel traffic is rare, beluga whales exhibited rapid swimming from ice-breaking vessels up to 80 km (49.7 mi) away, and showed changes in surfacing, breathing, diving, and group composition (Finley et al. 1990). In other cases, such as the St. Lawrence River where vessel traffic is common, beluga whales were more tolerant of vessels, but responded differentially to certain vessels and operating characteristics by reducing their calling rates (especially older animals). Belugas' response to vessels can result in temporary displacement (NMFS unpublished data).

Lesage et al. (1999) observed changes in the vocal behavior of beluga whales in the presence of a 7 m (23 ft) vessel powered by two 70 horsepower (HP) engines and a 2,173 gross-ton ferry 80 m (260 ft) long with two 2,000 HP engines each fitted with a propeller 235 cm in diameter. Vocal responses included a reduction in call rate, an increase in emissions of certain call types, repetition of specific calls and a shift in frequency bands. Responses occurred more frequently when exposed to the ferry than the small vessel. Scheifele et al. (2005) documented an increase in the intensity of vocalizations in belugas exposed to different vessel traffic in the St. Lawrence Estuary. Gervaise et al. (2012) suggests that the chronic anthropogenic noise associated with ship traffic in the Saguenay mouth likely masks beluga whale communication and echolocation vocalizations. Blane and Jaakson (1994) observed avoidance behavior by belugas in the presences of a 5 m (16 ft) inflatable boat with an outboard motor. Avoidance behavior of the belugas included decreased surfacing, increased speed and bunching into groups. Once the disturbance ceased, belugas resumed their previous behavior. However, Blackwell and Greene (2003) observed beluga whales in close proximity of the *Northern Lights* cargo-freight ship docked with motors running (126 dB re 1 µPa) at the POA, indicating that the belugas were not particularly bothered by the stationary ship.

As also is discussed in Section 6 (“Effects to Cook Inlet beluga whale critical habitat”), vessel noise 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)).

Overall, project vessel activity will increase vessel noise in Cook Inlet for the duration of the proposed action. To minimize the effects of noise associated with vessel activity on marine mammals in the area, Hilcorp will implement mitigation and monitoring measures discussed in Section 2.1.1 and will follow NMFS’s Marine Mammal Viewing Guidelines and Regulations (NMFS 2008b), which will reduce the likelihood of adverse effects on listed marine mammals.

With the implementation of these mitigation and monitoring measures, the impact of vessel noise is very minor, and thus adverse effects to Cook Inlet belugas will be immeasurably small. Furthermore, the probability of vessel noise rising above the threshold for Level B harassment is very small, and thus adverse effects to Cook Inlet belugas are extremely unlikely to occur. Therefore we conclude that adverse effects from vessel noise on Cook Inlet belugas are insignificant and discountable.

Humpback and Fin whales

Masking is of special concern for baleen whales that vocalize at low frequencies over long distances, such as humpback and fin whales, as their communication frequencies overlap with anthropogenic sounds such as shipping traffic. Some baleen whales have adjusted their communication frequencies, intensity, and call rate to limit masking effects. For example, McDonald et al. (1995) found that blue whales (*Balaenoptera musculus*) in California shifted their call frequencies downward by 31 percent since the 1960s, possibly to communicate below shipping sound frequencies. Melcon et al. (2012) found blue whales to increase their call rates in the presence of typically low frequency shipping sound, but to significantly decrease call rates when exposed to mid-frequency sonar. Fin whales have reduced their calling rate in response to boat noise (Watkins 1986). Right whales have been observed changing vocal behavior due to distance shipping that has increased overall background noise (Parks et al. 2007). Also, Di Lorio and Clark. (2010) found blue whales to communicate more often in the presence of seismic surveys, which they attributed to compensating for an increase in ambient sound levels.

Ship noise due to propeller cavitation can cause behavioral changes by baleen whales. Humpback whale reactions to approaching boats are variable, ranging from approach to avoidance (Payne 1978, Salden 1993). Baker et al. (1983) reported that humpbacks in Hawaii responded to vessels at distances of 2 to 4 km, however humpbacks showed no reaction at distances beyond 800 m when the whales were feeding (Watkins 1981, Kreiger and Wing 1986). Humpback whales are especially responsive to fast moving vessels (Richardson et al. 1995) exhibiting aerial behaviors such as breaching or tail/flipper slapping (Jurasz and Jurasz 1979). However, temporarily disturbed whales often remain in the area despite the presence of vessels (Baker et al. 1988, Baker et al. 1992).

Bauer and Herman (1986) concluded that reactions to vessels are probably stressful to humpback whales, but that the biological significance of that stress is unknown. Humpback whales seem less likely to react to vessels when actively feeding than when resting or engaged in other activities (Kreiger and Wing 1986). 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 rolling interspersed with dives. When vessels approached, the amount of time cows and calves spent resting and milling declined significantly.

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, it can interrupt behavioral and physiological events, alter time budget, or a combination of all these stressors (Sapolsky 2000)(Frid and Dill. 2002).

Overall, project vessel activity will increase vessel noise in Cook Inlet for the duration of the proposed action. To minimize the effects of noise associated with vessel activity on marine mammals in the area, Hilcorp will implement mitigation and monitoring measures discussed in Section 2.1.1 and will follow NMFS's Marine Mammal Viewing Guidelines and Regulations (NMFS 2008b), which will reduce the likelihood of adverse effects on listed marine mammals.

With the implementation of these mitigation and monitoring measures, the impact of vessel noise is very minor, and thus adverse effects to humpback and fin whales will be immeasurably small. Furthermore, the probability of vessel noise rising above the threshold for Level B harassment is very small, and thus adverse effects to humpback and fin whales are extremely unlikely to occur. Therefore we conclude that adverse effects from vessel noise on humpback and fin whales are insignificant and discountable.

Steller sea lions

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 cause disturbance to their normal behaviors (Calkins and Pitcher 1982, 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 (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 2008c).

Vessels that approach rookeries and haulouts at slow speed, in a manner that allows sea lions to observe the approach, should have less effects than vessels that appear suddenly and approach quickly (NMFS 2008c). 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. Repeated disturbances that result in abandonment or reduced use of rookeries by lactating females could negatively affect body condition and survival of pups through interruption of normal nursing cycles (NMFS 2008c). Pups are the age-class most vulnerable to disturbance from vessel traffic (NMFS 2008c).

Sea lions in the action area are more likely to respond to vessel noise when a project vessel passes a haulout than when a survey vessel passes a sea lion in the water. However, the implementation of mitigation measures, particularly vessels remaining more than 3 nm from major Steller sea lion rookeries and haulouts (Section 2), will make it unlikely that project vessels will disturb hauled out Steller sea lions. The effects of vessel presence on sea lions in open water is likely to be temporary and transient in nature as the vessel approaches and passes sea lions. Increases in ambient noise, however temporary, have the potential to mask communication between sea lions, and affect their ability to detect predators (Richardson and Malme 1993, Weilgart 2007).

Overall, project vessel activity will increase vessel noise in Cook Inlet for the duration of the proposed action. To minimize the effects of noise associated with vessel activity on marine mammals in the area, Hilcorp will implement mitigation and monitoring measures discussed in Section 2.1.1 and will follow NMFS's Marine Mammal Viewing Guidelines and Regulations (NMFS 2008b), which will reduce the likelihood of adverse effects on listed marine mammals.

With the implementation of these mitigation and monitoring measures, the impact of vessel noise is very minor, and thus adverse effects to western DPS Steller sea lions will be immeasurably small. Furthermore, the probability of vessel noise rising above the threshold for Level B harassment is very small, and thus adverse effects to western DPS Steller sea lions are extremely unlikely to occur. Therefore we conclude that adverse effects from vessel noise on western DPS Steller sea lions are insignificant and discountable.

6.2.2.9 Aircraft Operations

Helicopters and fixed wing aircraft will be used to support all the activities included in the scope of this proposed action. Helicopters will be used for crew changes and supplies for platforms, drilling rigs, and with the 3D seismic survey. Flight routes will follow a direct route to and from the rig or platform location, and flight heights will be maintained 300 to 450 m (1,000 to 1,500 ft), as practicable, above ground level (AGL) to avoid acoustical harassment of marine mammals (Section 2.1.1).

Helicopters and fixed-wing aircraft generate noise from their engines, airframe, and propellers. The dominant tones for both types of aircraft generally are greater than 500 Hz (Richardson et al. 1995). Richardson et al. (1995) reported that received sound levels in water from aircraft flying at an altitude of 152 m (approximately 500 ft) were 109 dB re 1 μPa for a Bell 212 helicopter, 101 dB re 1 μPa for a small fixed-wing aircraft, 107 dB re 1 μPa for a twin otter, and 124 dB re 1 μPa for a P-3 Orion.

Penetration of aircraft noise into the water is greatest directly below the aircraft; at angles greater than 13 degrees from vertical, much of the sound is reflected and does not penetrate Richardson et al. (1995). During calm seas, sound is completely reflected at larger angles and does not enter the water. However, during rough sea conditions, airborne sound may penetrate water at angles greater than 13°. Water depth and bathymetry can also influence the propagation of a noise from a passing aircraft into water. In shallow waters, lateral propagation is greater than in deep water, particularly when the sea floor is reflective. As the aircraft's altitude increases, the base of the cone gets bigger but the sound pressure levels (SPLs) reaching the water surface decrease because of distance.

Duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 152 m (approximately 500 ft), audible in air for 4 minutes, may be detectable underwater for 38 seconds at 3 m (10 ft) depth, and 11 seconds at 18 m (59 ft) depth (Richardson et al. 1995).

Marine mammals could be disturbed by the acoustic noise or physical presence of low-flying aircraft. Airborne noise and visual cues are more likely to disturb individuals resting at the sea surface or hauled out on ice or land (BOEM 2012). Marine mammals underwater at the time of exposure could also be disturbed by noise propagating beneath the surface of the water or by shadows of an aircraft flying overhead. Observations made from low-altitude aerial surveys report highly variable behavioral responses from marine mammals ranging from no observable reaction to diving or rapid changes in swimming speed/direction (Efroymson and Suter 2001, Smultea et al. 2008). In general, it is difficult to determine if behavioral reactions are due to aircraft noise, to the physical presence and visual cues associated with aircraft, or a combination of those factors (Richardson et al. 1995).

Beluga whales

Patenaude et al. (2002) found that beluga whales in the Beaufort Sea reacted more strongly to helicopters than fixed-wing aircraft. Reactions increased significantly to helicopters at lateral distances of less than 250 m (820 ft), and belugas reacted more often when fixed-wing aircraft were at altitudes of less than 182 m (597 ft). Luksenburg and Parsons (2009) noted that these reactions may have been elicited by the mid-frequency sound of the aircraft, visual cues, or both.

During the NMFS aerial surveys, which are flown at 800 m, whale groups are known to occasionally split or merge, but seemingly not in response to survey aircraft. Whales are often seen swimming in the same direction and speed throughout the aerial circling procedure, without any observed change in activity (Rugh et al. 2000). Aircraft pose no apparent threat to the whales, and evidence suggests that they have habituated to the aerial traffic generated by several major airports around upper Cook Inlet (Rugh et al. 2000). However, ground-based biologists note that Cook Inlet belugas often dive and remain submersed for longer than is typical when aircraft fly past at low altitudes or circle them (NMFS unpublished data). Individual responses of belugas may vary, depending on previous experiences, beluga activity at the time of the noise, and noise characteristics.

With the implementation of mitigation measures such as flying at altitudes above 1,000 m for aerial surveys before seismic surveys and above 1,500 m during other operations (Section 2.1.1), the impact of project aircraft is very minor, and thus the adverse effects to Cook Inlet belugas will be immeasurably small. Therefore, we conclude that the adverse effects from this stressor are insignificant.

Humpback and fin whales

Research into the responses of baleen whales to aircraft noise is limited, however there have been a few studies on bowhead and gray whales which can be used to infer the likely responses of humpback and fin whales. The noise and visual presence of aircraft can result in behavioral changes in bowhead whales such as diving, altering course, vigorous swimming, and breaching (Patenaude et al. 2002), slapping the water with flukes or flippers, and swimming away or turning away from the aircrafts flight direction.

Ljungblad et al. (1987) found that gray whale response was heavily influenced by age, sex, and behavior at the time of the aircraft overflight. Calves were seen to swim under their mothers in response to a fixed-wing aircraft flying at an altitude of 305 m. Migrating gray whales changed their speed and course in response to playback of a Bell 312 helicopter, and when the helicopter was below 250 m, reactions included abrupt turns and dives. However mating gray whales did not respond to repeated circling of a fixed-wing aircraft at 320 m.

Some humpback whales have shown a response to an aircraft at 305 m, while other whales have shown no response to an aircraft at 152 m (Richardson et al. 1995). Whales are less reactive in larger feeding or social groups and more reactive in confined waters or with calves. Reactions by cetaceans are likely influenced by group size and behavioral activity (Richardson et al. 1995, Patenaude et al. 2002, Weilgart 2007).

With the implementation of mitigation measures such as project aircraft flying at 1,000 m for pre-seismic surveys, and 1,500 m for all other aircraft operations, we do not expect humpback and fin whales to respond to aircraft. For these reasons, the impact of project aircraft is very minor, and thus the adverse effects to humpback and fin whales will be immeasurably small. Therefore, we conclude that the adverse effects from aircraft disturbance on listed humpback and fin whales are insignificant.

Steller sea lions

Sea lion pups on land are vulnerable to trampling if adults are panicked by low flying aircraft. Calkins and Pitcher (1982) reported that the reaction of Steller sea lions to aircraft is variable.

Withrow (1982) witnessed 1,000 + animals stampede off a beach in response to a Bell 205 helicopter greater than 1.6 km away (Richardson et al. 1995). 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.

Steller sea lion response to aircraft is likely dependent upon age, sex, and season. Calkins (1979) found that dominant, territory-holding males and females with young are less likely to leave a haulout site in response to an aircraft overflight than are juveniles and pregnant females.

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 do not expect Steller sea lions to be adversely affect by the noise or presence of aircraft.

The impact of project aircraft is very minor, and thus adverse effects to Steller sea lions will be immeasurably small. Therefore, we conclude that the adverse effects from project aircraft on Steller sea lions are insignificant.

6.2.3 Effects of Noise on Prey Species

6.2.3.2 Zooplankton

Zooplankton is a food source for several marine mammal species, including humpback whales, as well as a food source for fish that are then prey for marine mammals. Population effects on zooplankton could therefore have indirect effects on marine mammals. The primary generators of sound energy associated with activities in this opinion include seismic surveys, geohazard and geotechnical surveys, vessels, exploratory drilling, pipe installation, and routine maintenance activities on the pipelines. (Popper and Hastings 2009) reviewed information on the effects of pile driving and concluded that there are no substantive data on whether the high sound levels from pile driving or any man-made sound would have physiological effects on invertebrates. Any such effects would be limited to the area very near (1 to 5 m [3.2 to 16.4 ft]) the sound source and would result in no population effects due to the relatively small area affected at any one time and the reproductive strategy of most zooplankton species (short generation, high fecundity, and very high natural mortality).

No adverse impact on zooplankton populations would be expected to occur from these activities, 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 would be expected to be negligible compared to the naturally occurring high reproductive and mortality rates. Impacts from sound energy generated by vessels would be expected to have even less impact, as these activities produce much lower sound energy levels.

6.2.3.3 Benthos

No 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 because of operations are negligible compared to the naturally occurring high reproductive and mortality rates.

6.2.3.4 Fish

Fish are the primary prey species for marine mammals in Cook Inlet. Beluga whales feed on a variety of fish, shrimp, squid, and octopus (Burns and Seaman 1986). Common prey species in Knik Arm include salmon, eulachon and cod. Steller sea lions are generalist predators that eat a variety of fish and cephalopods (Pitcher and Calkins 1981, Calkins and Goodwin 1988, NMFS 2008a). Humpback whales feed on small schooling fishes, euphausiids, and other large zooplankton. Humpbacks' fish prey species in the North Pacific include Pacific herring, capelin, juvenile walleye pollock, and sand lance. Humpback also feed on eulachon, Atka mackerel, Pacific cod, saffron cod, Arctic cod, juvenile salmon, and rockfish (Hain et al. 1982).

In general, fish perceive underwater sounds in the frequency range of 50 to 2,000 Hz, with peak sensitivities below 800 Hz (Popper et al. 2005). However, fish are sensitive to underwater impulsive sounds due to swimbladder resonance. As the pressure wave passes through a fish, the swimbladder is rapidly squeezed as the high-pressure wave passes through the fish. The swimbladder may repeatedly expand and contract at the high SPLs, creating pressure on the internal organs surrounding the swimbladder.

Popper et al. (2005), in a review of 40 years of studies concerning the use of underwater sound to deter salmonids from hazardous areas at hydroelectric dams and other facilities, concluded that salmonids were able to respond to low-frequency sound and to react to sound sources within a few feet of the source. They speculated that the reason that underwater sound had no effect on salmonids at distances greater than a few feet is because they react to water particle motion/acceleration, not sound pressures. Detectable particle motion is produced within very short distances of a sound source, although sound pressure waves travel farther.

Hastings and Popper (2005) reviewed all pertinent peer-reviewed and unpublished papers on noise exposure of fish through early 2005. They proposed the use of SEL to replace peak SPL in pile driving criteria. This report identified interim thresholds based on SEL or sound energy. The interim thresholds for injury were based on exposure to a single pile driving pulse. The report also indicates that there was insufficient evidence to make any findings regarding behavioral effects associated with these types of sounds. Interim thresholds were identified for pile driving consisting of a single-strike peak SPL and a single strike SEL for onset of physical injury. A peak pressure criterion was retained to function in concert with the SEL value for protecting fishes from potentially damaging aspects of acoustic impact stimuli. The available scientific evidence suggested that a single-strike SPL of 208 dB and a single strike SEL of 187 dB were appropriate thresholds for the onset of physical injury to fishes.

Following the Hastings and Popper (2005) paper, the dual criteria was developed that included the single strike peak SPL of 208 dB, but addressed the accumulation of multiple strikes through accumulation of sound energy by setting a criterion of 187 dB SEL. The accumulated SEL is calculated using an equal energy hypothesis that combines the SEL of a single strike to 10 times the 10-based logarithm of the number of pile strikes.

Several caged fish studies on the effects of pile driving have been conducted, and most have involved salmonids. Ruggerone et al. (2015) exposed caged juvenile coho salmon (93 to 135 millimeters) at two distance ranges (near 1.8 to 6.7 m and distance 15 m) to 0.5-m-diameter steel piles driven with a vibratory hammer. Sound pressure levels reached 208 dB re 1 µPa peak, 194 dB re 1 µPa rms, and 179 dB re 1 $\mu Pa^2 s$ SEL, leading to a cumulative SEL of approximately 207 dB re 1 µPa^{2}s during the 4.3-hr period. All observed behavioral responses of salmon to pile strikes were subtle; avoidance response was not apparent among fish. No gross external or internal injuries associated with pile driving sounds were observed. The fish readily consumed hatchery food on the first day of feeding (day 5) after exposure. The study suggests that coho salmon were not significantly affected by cumulative exposure to the pile driving sounds.

Hart Crowser (2009) similarly exposed caged juvenile (86 to 124 millimeters, 10 to 16 grams) coho salmon to sheet pile driving in Cook Inlet using vibratory and impact hammers. Sound pressures measured during the acoustic monitoring were relatively low, ranging from 177 to 195 dB re 1 µPa peak, and cumulative SEL sound pressures ranging from 179.2 to 190.6 dB re 1 µPa^{2}s. No measured peak pressures exceeded the interim criterion of 206 dB. Six of the 13 tests slightly exceeded the SEL criterion of 187 dB for fish over 2 grams. No short-term or long-term mortalities of juvenile hatchery coho salmon were observed in exposed or reference fish, and no short- or long-term behavioral abnormalities were observed in fish exposed to pile driving sound pressures or in the reference fish during post-exposure observations.

Fish have been shown to react when engine and propeller sounds exceeds a certain level (Olsen et al. 1983, Ona 1988, Ona and Godø 1990). Avoidance reactions have been observed in fish such as cod and herring when vessel sound levels were 110 to 130 dB re 1 µPa rms (Ona and Toresen 1988, Ona and Godø 1990, Nakken 1992). Vessel sound source levels in the audible range for fish are typically 150 to 170 dB re 1 µPa/Hz (Richardson et al. 1995). The vessels used during the activities would be expected to produce levels of 170 to 175 dB re 1 µPa rms when in transit. Based upon the reports in the literature and the predicted sound levels from these vessels, there may be some avoidance by fish in the immediate area.

Based on the above information, fish may respond to noise associated with the proposed action by avoiding the immediate area. However, impact of noise on marine mammal prey is very minor, and thus adverse effects to Cook Inlet beluga whales, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions will be immeasurably small. Furthermore, the probability of noise impacts on marine mammal prey occurring is very small, and thus adverse effects to Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are extremely unlikely to occur. Therefore, we conclude that the adverse effects from noise impacting marine mammal prey, and thus affecting Cook Inlet beluga, Mexico DPS and Western North Pacific DPS humpback, fin whales, and western DPS Steller sea lions are insignificant and discountable.

6.2.4 Vessel Strikes

There may be an increased risk of vessel strike due to the increased traffic associated with the proposed action. Vessel collisions with marine mammals can lead to the death of the animal that was struck. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or a vessel's propeller could injure or kill an animal below the water's surface.

Vessel collisions with fin and humpback whales remain a management concern, given the increasing abundance of humpback whales foraging in Alaska, as well as the growing presence of marine traffic in Alaska's coastal waters and in particular Cook Inlet with its increased marine infrastructure. Based on these factors, injury and mortality of humpback and fin whales as a result of vessel strike may likely continue, or possibly increase, in the future (NMFS 2010c, Muto et al. 2018).

On the Pacific coast, an estimated 2.7 humpback whales are killed every year by ship strikes (Muto et al. 2016). Between 1978 and 2011, there were 108 reports of whale-vessel collisions in Alaska waters. Of these, 93 involved humpback whales (Neilson et al. 2012). Most vessel collisions with humpbacks are reported from Southeast Alaska, and it is not known whether the difference in ship strike rates between Southeast Alaska and other portions of the humpback whale range in Alaska is due to differences in reporting, amount of vessel traffic, densities of animals, and/or other factors (Muto et al. 2016). In 2001, a humpback whale was discovered on the bulbous bow of a 710 ft container ship as it docked in the Port of Anchorage. It is unknown where the vessel may have collided with the whale (NMFS Alaska Regional Office Stranding Database accessed May 2019).

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). Fin whale mortality due to ship strikes in Alaska waters (one each in 2010 and 2014) has also been reported to the NMFS Alaska Region stranding network (Helker et al. 2017), resulting in a mean annual mortality and serious injury rate of 0.4 fin whales due to ship strikes in 2010 through 2014 (Muto et al. 2016).

While humpback whales are among the marine mammal species most prone to ship strikes in Alaska, the slow operational speeds of project vessels will help minimize the risk of collision for any humpback or fin whales that may be present in the action area. An examination of all known ship strikes for large (baleen and sperm) whales from all shipping sources indicates vessel speed is a principal factor in whether a vessel strike results in death (Laist et al. 2001, Vanderlaan and Taggart 2007). In assessing records with known vessel speeds, Laist et al. (2001) found that most deaths occurred when a vessel was traveling in excess of 24.1 km/h (14.9 mph; 13 kts).

For the proposed action, seismic vessels will travel at speeds between 3 and 4 kn and infrastructure maintenance and small support vessels will travel at speeds between 3 and 7 kn. These operating speeds, in combination with the implementation of mitigation measures such as further speed reductions and course alterations when whales are seen within 1 mi of project vessels (Section 2.1.2), greatly decreases probability of project-related humpback and fin whale vessel strikes. The probability of a Western North Pacific or Mexico DPS humpback, or fin whale being struck by a project vessel is extremely small (about 1/10th the probability of any humpback whale being struck), and thus adverse effects to listed humpback and fin whales are extremely unlikely to occur. Therefore, we conclude that the adverse effects from vessel strikes on listed humpback and fin whales are discountable.

Ship strikes of smaller cetaceans such as beluga whales are much less common, possibly due to their smaller size and more agile nature. However, while likely rare, vessel strikes of belugas have been documented in the St. Lawrence River Estuary (Lair et al. 2015). In Cook Inlet, a dead beluga whale washed ashore 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 Cook Inlet belugas (LGL Alaska Research Associates 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.

Similar to belugas, the agility of Steller sea lions is likely to preclude vessel strikes. 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 2008c). In 2007, a Steller sea lion was found in Kachemak Bay that may have been a part of a boat collision. The Steller sea lion had two separate wounds consistent with blunt trama (NMFS Alaska Regional Office Stranding Database accessed May 2019).

Based on the slow vessel speeds, the implementation of mitigation measures to minimize exposure to vessel activities, and the rarity of collisions with marine mammals in Cook Inlet, we conclude that the probability of a Hilcorp project vessel striking a Cook Inlet beluga whale or Western DPS Steller sea lion is very small, and thus adverse effects to Cook Inlet beluga whales and Western DPS Steller sea lions are extremely unlikely to occur. Therefore, we conclude that the adverse effects from vessel strikes on Cook Inlet beluga whales and Western DPS Steller sea lions are discountable.

6.2.5 Seafloor Disturbance and Habitat Alteration

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.

The sources of seafloor disturbance from activities included in the proposed action include placement of nodes during the 2D seismic survey, boring during geotechnical surveys, drilling wells, construction if the Iniskin causeway, and some maintenance activities on existing pipelines.

6.2.5.1 Seismic Node Placement

Potential effects from seafloor disturbance as a result of the 2D seismic surveys in which the placement of the small nodes may temporarily affect the seafloor habitat. The nodes for the 2D seismic survey will be deployed on each source line for less than a day and will be retrieved. Although the placement of the nodes 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 immeasurably small impact on foraging and primary prey for listed species.

6.2.5.2 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 or grab sampler. The boring equipment used for geotechnical surveys are generally small in diameter with only a few over the area to be surveyed, so the area of total disturbance is very small and temporary.

Sampling in soft bottom areas will produce only minor and highly localized turbidity, which is expected to rapidly dissipate in the inlet's strong tidal currents when sampling ends (BOEM 2017). Furthermore, in the highly turbid waters of Cook Inlet, increases in turbidity would be nearly imperceptible. Seafloor disturbance from anchor handling activities is anticipated to fill in through natural movement of sediment over time. Thus, any effects to listed species would be insignificant.

6.2.5.3 Exploratory Drilling

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 2017).

The total area of disturbed sediment due to jack-up rig legs will depend on the rig design and diameters of the legs. BOEM (2017) estimated each setup of a jack-up rig results in approximately 2.5 acres of seafloor disturbance. Hilcorp proposes to conduct its exploratory drilling using a rig similar to the *Spartan 151* drill rig. The *Spartan 151* is a 150 H class independent leg, cantilevered jack-up drill rig with a drilling depth capability of 7,620 m (25,000 ft) that can operate in maximum water depths up to 46 m (150 ft).

The use of the jack-up rigs disturbs the seafloor due to the placement and removal of stabilizers (i.e., the drilling rig legs on a jack-up rig). The area of disturbance will vary based on the specific drill rig used and Cook Inlet currents, but in most cases includes the area of disturbance from the mudline cellar, the anchoring system, displacement of sediments, and discharge of drilling waste will be small.

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. 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 2016).

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.

Seafloor disturbance, turbidity, and discharge from activities may impact marine mammal prey species and potentially the fitness of marine mammals. Turbidity may affect the prey species distribution and diversity as well as the ability of marine mammals to locate prey in the immediate area of the drilling activity. The discharge of drilling fluids and cuttings during drilling activities is unlikely to have large-scale effects on marine mammals, either directly through contact with marine mammals or indirectly by affecting their prey, because the effects would be restricted primarily to the areas immediately surrounding the drillsite and the areas of supporting anchors and chains. The presence of the drill rig is not expected to result in direct loss of marine mammal habitat, but it could result in a minimal loss of marine mammal foraging areas.

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 2015b). 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 to recolonize, taking generally less than a year for establishment in new locations (Trannum et al. 2011).

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 exploratory drilling activities and would consider this stressor to be minor or minimal overall.

Discharging drill cuttings or other liquid waste streams generated by the drilling could affect marine mammal habitat and prey. The main impacts from drilling discharges would be temporary turbidity in the water column and localized alteration of the benthic environment around individual wellsites. The settling of drilling fluid and cutting discharge would result in physical disturbance of habitats through the smothering of benthic areas/species as well as the disturbance of pelagic species (Tetra Tech Inc. 2012). Because the food supply for listed marine mammals consists of benthic and pelagic species, this could have a localized impact on their food supply (Tetra Tech Inc. 2012), but the effects would be immeasurably small and thus insignificant.

6.2.5.4 Iniskin Causeway

The Iniskin causeway will result in 2.65 acres of seafloor disturbance and loss of habitat. After the causeway is no longer needed for the project, it is proposed that rock fill be removed and relocated to a landowner- approved upland fill area, exposing the natural mud flat surface. Tidal action, wave action, and currents will naturally restore the area disturbed by the causeway.

Overall, seafloor disturbance and habitat alteration could have highly localized, short-term effects to marine mammals. Potential effects from seafloor disturbance are likely to limit the foraging quality of the disturbed area temporarily, but listed species would likely forage elsewhere and any effects on their foraging would be immeasurably small, and thus insignificant.

6.2.6 Introduction of Pollutants into Waters

For this proposed action, large and small quantities of hazardous materials, including diesel fuel and gasoline, would be handled, transported, and stored following the rules and procedures described in the Spill Prevention, Control, and Countermeasure Plan.

6.2.6.2 Authorized Discharges

Authorized discharges from project activities 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 permit number AKG285100 (under a separate ESA consultation), 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 2017).

As previously mentioned in the *Environmental Baseline* section of this opinion, pollutants in discharges from oil and gas 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 2010b, EPA 2015).

6.2.6.3 Unauthorized spills

Probability of a spill

Increased vessel activity in the action area will temporarily increase the risk of accidental fuel and lubricant spills from support vessels. Accidental spills may occur from a vessel leak or if the vessel runs aground. Associated vessels and structures will maintain and adhere to approved Spill, Prevention, Control, and Countermeasure plans as well as Oil Discharge Prevention and Contingency Plan (ODPCP). These plans include required adherence to NMFS's Pinniped and Cetacean Oil Spill Response Guidelines (NMFS-OPR-52).

Although it would be an extremely rare event, a well blowout is a potential risk. Though oil spills from offshore platforms up to 250 barrels have occurred, no oil well blowouts have been documented in Cook Inlet. Four gas blowouts have occurred in Cook Inlet since 1962, with the last occurring in 1987[20].

There are different probabilities of potential occurrence between the various sized oil spills (small, large, and very large oil spill [VLOS]). It is more likely that a small oil spill could occur in association with oil exploration activities than a large or VLOS (Table 37; (BOEM 2017)). 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.

Table 37. BOEM's estimated total number of refined and crude or liquid gas condensate oil spills during the exploration and development of the OCS blocks of Lease Sale 244 (BOEM 2016, 2017).

Activity	Source of Spill	Number of Spill(s)[1]		Size of Spill(s) (in bbl)	Estimated Total Spill Volume	Frequency of Occurrence
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.

NMFS (2017b) and BOEM (2017) discussed the Oil Spill Risk Analysis (OSRA) conducted by BOEM which looked at probabilities of various sized spills contacting waters and shorelines of Cook Inlet and Shelikof Strait. The OSRA estimated that 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 and if the spill occurred during the open-water season (April 1 through October 31) could cover an estimated discontinuous area of 59 km^2 after 3 days and 1,159 km^2 after 30 days. A spill that occurs during broken ice conditions

[20] https://dec.alaska.gov/Applications/SPAR/PublicMVC/PERP/SpillSearch

would not disperse as quickly, however oiled ice that drifts and subsequently melts during open water would introduce oil into surface waters in new areas (BOEM 2016, 2017).

General Effects of Exposure to Oil and Gas

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. Injury and mortality to whales are most likely during the initial spill event. 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.

Ingestion of hydrocarbons can irritate and destroy epithelial cells in the stomach and intestine of marine mammals, affecting motility, digestion, and absorption, which may result in death or reproductive failure (Geraci and St. Aubin 1990). Direct ingestion of oil, ingestion of contaminated prey, 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 1990, Frost et al. 1994, Spraker et al. 1994, Jenssen 1996, Jenssen et al. 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).

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 marine mammals 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.

Whales (beluga, fin, and humpback)

Depending on the timing and location of a spill, beluga, fin, and humpback whales could briefly be exposed to small spills of refined oil. Small spills in the upper Cook Inlet are more likely to affect beluga whales, which are more common in the upper Inlet, while small spills in the lower Inlet are more likely to affect humpback and fin whales, which are seen more commonly in the lower Inlet. In the case of a large oil spill, given the large area that is expected to be affected (1,159 km^2 after 30 days; (NMFS 2017b)) it is likely that all species would be exposed to oil to some degree whether the spill occurred in the lower or upper Inlet.

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 1990).

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 1990), have anaesthetic effects (Neff 1990), and cause death (Geraci and St. Aubin 1990). 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.

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 2016). 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 2016a).

Although Cook Inlet beluga whales currently have lower contaminant loads (including PAHs) than other populations of beluga whales (Becker et al. 2000), 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, Martineau et al. 2002); however, no definitive causal relationship has been demonstrated (BOEM 2016). 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.

If a spill (especially a large or 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 (NMFS 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 2016).

Humpback whales are at highest risk from impacts to oil spills during the summer and fall in their feeding areas around Kodiak Island which were described as Biologically Important Areas (BIAs) for humpback and fin whale feeding (Ferguson et al. 2015). The highest densities of humpback whales in this BIA occur from July through September (Witteveen and Quinn Ii 2007, Witteveen et al. 2011). Another area of high use by humpback whales in the summer occurs just north of the feeding BIA, on the southern extent of the Kenai Peninsula (BOEM 2016). Because of their distribution, the primary potential adverse effect on humpback whales would be from a large spill that contacted waters adjacent to Kodiak Island, including Shelikof Strait, especially during the summer and into the fall for humpback whales when densities are highest in this area (BOEM 2016).

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 2016). 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.

Fin and humpback whale prey (schooling forage fish and zooplankton) could be reduced or contaminated, leading to modified distribution of these whales (BOEM 2015b, 2016). Duesterloh et al. (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 2016).

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. 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 2016).

Steller Sea Lions

Steller sea lions are more likely to be impacted by a small oil spill that occurs in the lower Inlet, since they are less commonly seen in the Upper Inlet. 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. In the case of a large oil spill, given the large area that is expected to be affected (1,159 km^2 after 30 days; (BOEM 2016, 2017)) it is likely that all marine mammals in Cook Inlet would be exposed to oil to some degree whether the spill occurred in the lower or upper Inlet.

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. Steller sea lions occur year round in the action area, but are more common in lower Cook Inlet.

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. 1994). After the Exxon Valdez oil spill, Calkins et al. (1994) recovered 12 Steller sea lion carcasses from the beaches of Prince William Sound and collected 16 additional Steller sea lions from haul-out sites in the vicinity of Prince William Sound, the Kenai coast, and the Barren Islands. The highest levels of PAHs were in animals found dead following the oil spill in Prince William Sound. Furthermore, sea lion bile samples collected 7 months after the spill had levels of PAH metabolites consistent with exposure to PAHs (Calkins et al. 1994). However, histological examinations found no lesions that could be attributed to hydrocarbon contamination and, hence, no evidence of damage due to oil toxicity (Calkins et al. 1994).

Crude oil immersion studies resulted in 100 percent mortality in captive ringed seals (Geraci and Smith 1976). Unlike the animals in the immersion study, pinnipeds 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 1990). 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).

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 2016). 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.

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 small oil spill and exposing Cook Inlet beluga whales, humpback whales, fin whales, and Steller sea lions is extremely unlikely to occur as to be considered discountable. If exposure were to occur, due to the ephemeral nature of small, refined oil spills, NMFS does not expect detectable responses from listed marine mammals and would consider exposure insignificant.

In contrast to small oil spills, large and very large oil spills are a low probability but high impact event in which large numbers of listed marine mammals may experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, which could result in injury and mortality of a substantial number of listed marine mammals.

Spill Response

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. Oil spill response activities have been previously consulted on by NMFS as part of the *Unified Plan* (AKR-2014-9361).

Gas releases

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.

6.2.7 Entanglement

Towed gear from the seismic survey activities pose a risk of entanglement to ESA-listed marine mammals. The towed hydrophone streamer could come in direct contact with ESA-listed species. However, entanglement is highly unlikely due to the towed hydrophone streamer design. Entanglement with streamers during other seismic surveys using similarly-designed equipment has been rare, and there are no records of entanglement of listed marine mammals with such gear. The towed hydrophone streamer is rigid and the cables are taut, therefore reducing the likelihood of a marine mammal becoming entangled. One potential instance of a marine mammal entanglement occurred during a National Science Foundation-funded seismic survey off the coast of Costa Rica during 2011. A dead olive ridley turtle (*Lepidochelys olivacea*) was found in the foil of towed seismic equipment; it was unclear whether the sea turtle became lodged in the foil pre- or post mortem (Spring 2011 as cited in (NMFS 2018c).

Although the towed hydrophone streamer could come in direct contact with an ESA-listed species, entanglements are highly unlikely and considered discountable. Based upon extensive deployment of this type of equipment with no reported entanglement and the nature of the gear that is likely to prevent it from occurring, we find the probability of entanglement of ESA-listed species occurring is very small, and thus adverse effects to ESA-listed species are extremely unlikely to occur. Therefore, we conclude that the adverse effects from entanglement on ESA-listed species are discountable.

6.2.8 Trash and Debris

The Hilcorp Cook Inlet gas and oil project will generate trash comprised of paper, plastic, wood, glass, and metal mostly from galley and food service operations. A substantial amount of waste products could be generated from construction, production, and decommissioning activities. The possibility exists that trash and debris could be released into the marine environment. While this type of trash and debris discharge is illegal, it does occur and can pose significant risks to marine mammals; it is anticipated to be more common and widespread (and impactful) than oil spills.

Hilcorp will to comply with Federal regulations, so the amount of trash and debris occurring within the action area is expected to be minimal. The impact of trash and debris is very minor, and thus adverse effects to ESA-listed species will be immeasurably small. Therefore, we conclude that the adverse effects from trash and debris on ESA-listed species are insignificant.

6.2.9 Effects to Critical Habitat

Cook Inlet beluga whale and Steller sea lion critical habitat are within the action area of this project (Figure 17, Figure 26, and Figure 10). The following sections describe the effects of the proposed Hilcorp Alaska's oil and gas activities in Cook Inlet on designated Cook Inlet beluga whale and Steller sea lion critical habitat.

6.2.9.1 Cook Inlet Beluga Whale Critical Habitat

Section 4.1.1.6 describes the geographical extent and Physical and Biological Features (PBFs) of designated Cook Inlet Beluga Whale Critical Habitat. The proposed action may affect critical habitat primarily through noise from the sources discussed in Section 6.2.2 and 6.2.3, including seismic, geohazard and geotechnical surveys, conductor pipe and sheet pile driving, vertical seismic profiling, and vessel and aircraft activity. Other activities that may affect critical habitat include effects to prey, disturbance to the seafloor and possible release of pollutants. The effects of the proposed action on these PBFs are described below.

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

There are twenty three anadromous fish streams that are within 8 km (5 mi) from the action area;

12 in lower Cook Inlet and 13 in middle Cook Inlet (Table 38; Figure 36; Figure 37). Approximately 683.6 km^2 (195.6 mi^2) of intertidal and sub tidal waters and habitat within 8 km (5 mi) of anadromous fish streams exist in the action areas. This includes 506.7 km^2 (195.6 mi^2) in lower Cook Inlet (Table 38; Figure 36) and 176.9 km^2 (68.5 mi^2) in middle Cook Inlet (Table 38; Figure 37).

Table 38. PBF1 list of anadromous fish streams and the 8 km (5 mi) area surrounding the streams that overlap the action areas in the lower and middle Cook Inlet.

Lower Inlet	Area km^2 (mi^2)	Middle Inlet	Area km^2 (mi^2)
Anchor River	113.5 (43.8)	Cannery Creek	6.1 (2.4)
Chinitna River	0.8 (0.3)	Chuitna River	3.0 (1.2)
Deep Creek	112.5 (43.5)	Drift River	6.1 (2.4)
Fitz Creek	0.8 (0.3)	Indian Creek	0.7 (0.3)
Kasilof River	70.0 (27.0)	Little Jack Slough	4.9 (1.9)
Marsh Creek	0.8 (0.3)	McArthur River	46.1 (17.8)
Ninilchik River	101.1 (39.0)	Middle River	29.0 (11.2)
Roscoe Creek	0.8 (0.3)	Montana Bill Creek	0.8 (0.3)
Stariski Creek	104.0 (40.2)	Nikolai Creek	23.2 (9.0)
Trail Creek	0.8 (0.3)	Old Tyonek Creek	34.7 (13.4)
West Glacier Creek	0.8 (0.3)	Seven Egg Creek	13.4 (5.2)
Wrong Branch Trail Creek	0.8 (0.3)	Threemile Creek	0.4 (0.1)
		Tyonek Creek	8.5 (3.3)
Total Area:	506.7 (195.6)	Total Area:	176.9 (68.5)

In the Lower Inlet, the construction of the causeway in Chinitna Bay overlaps with PBF1. Streams of particular concern are Fitz Creek, Wrong Branch Trail Creek, Roscoe Creek, Chinitna River, Marsh Creek, and West Glacier, totaling 5.6 km^2 (2.1 mi^2) (Table 38; Figure 37). The construction in this area will include vibratory sheet pile driving and rock laying for construction of the causeway that will extend 1,200 ft into the bay. The causeway itself is likely to impact these streams and the anadromous fish (including smolt) by altering the flow of water within Chinitna Bay. The turbidity resulting from vibratory sheet pile driving and rock laying is expected to be localized and largely indistinguishable from ambient turbidity.

The 2D seismic surveys will occur near five anadromous fish streams: Kasilof River, Ninilchik River, Deep Creek, Stariski Creek, and the Anchor River (Figure 36). These surveys may cause temporary disturbance to the area from vessels and noise, but are not expected to have permanent effects to these areas.

In the Upper Inlet, the Drift River Terminal (scheduled for decommissioning as part of this action) is within 5 mi of four anadromous fish streams: Little Jack Slough, Cannery Creek, Drift River, and Montana Bill Creek. In-water activities at the Drift River Terminal include vessel traffic (maintenance, supplies, etc.), and the receiving crude oil via the Cook Inlet Pipeline. The primary concern around the Drift River Terminal with respect to PBF1 is the possibility of oil spills, as a spill would likely have significant impacts to the nearby anadromous streams. The facility lies near an active volcano, Mt. Redoubt, which erupted in 2009 forcing the evacuation of the terminal and draw-down of oil stored on-site (Alaska Journal of Commerce 2009). A small spill (42 gal) at the Drift River Terminal occurred on April 27, 2019 according to the ADEC

Statewide Spill Database[21].

Also in the Upper Inlet, activities within Trading Bay (including multiple platforms where drilling will occur, the Granite Point Tank Farm, vessel traffic, and tugs on tow) will occur within 5 mi of seven anadromous streams: McArthur River, Middle River, Nikolai Creek, Old Tyonek Creek, Indian Creek, Chuitna River, and Threemile Creek. The pipeline from the Tyonek Platform also connects to the eastern shore near Seven Egg Creek.

A concern with respect to all of the anadromous streams is the possibility of an oil spill, and the resulting impacts to beluga prey. The sections below on PBF2 and PBF3 discuss this concern (see also Section 6.2.6).

The probability of these activities (construction of the causeway, the 2D seismic surveys, or an oil spill occurring) adversely affecting anadromous streams is very small, and thus adverse effects to PBF1 are extremely unlikely to occur. Therefore we conclude that adverse effects from the proposed action on PBF1 are discountable.

[21] http://dec.alaska.gov/Applications/SPAR/PublicMVC/PERP/SpillSearch

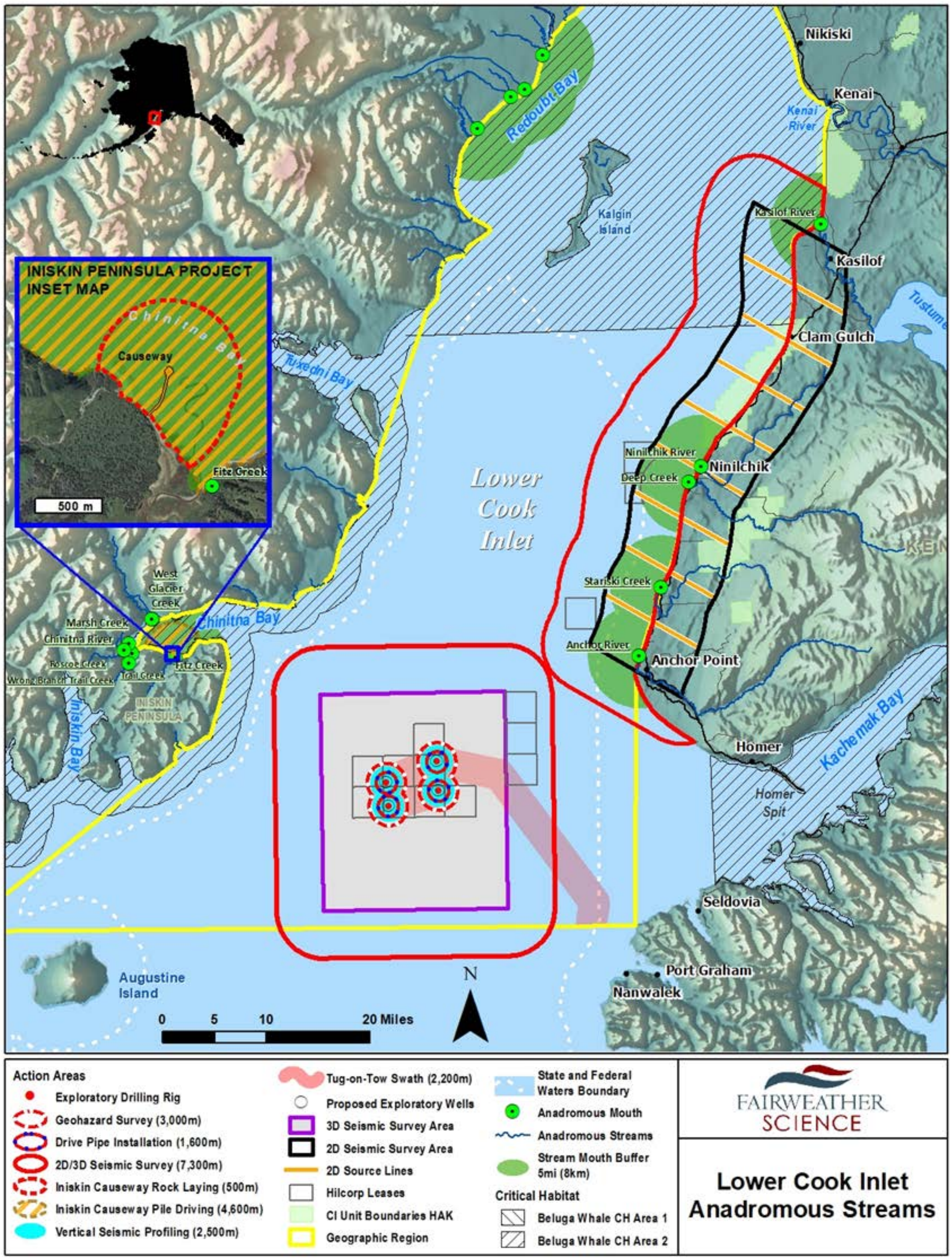

Figure 36. Physical and Biological Features (PBF) 1 intertidal and sub tidal waters of Cook Inlet with depths less than 9.1 m (30 ft; MLLW) and within 8 km (5 mi) of high and medium flow of anadromous fish streams in the lower Cook Inlet action areas. The area of PBF1 at each anadromous stream is in green.

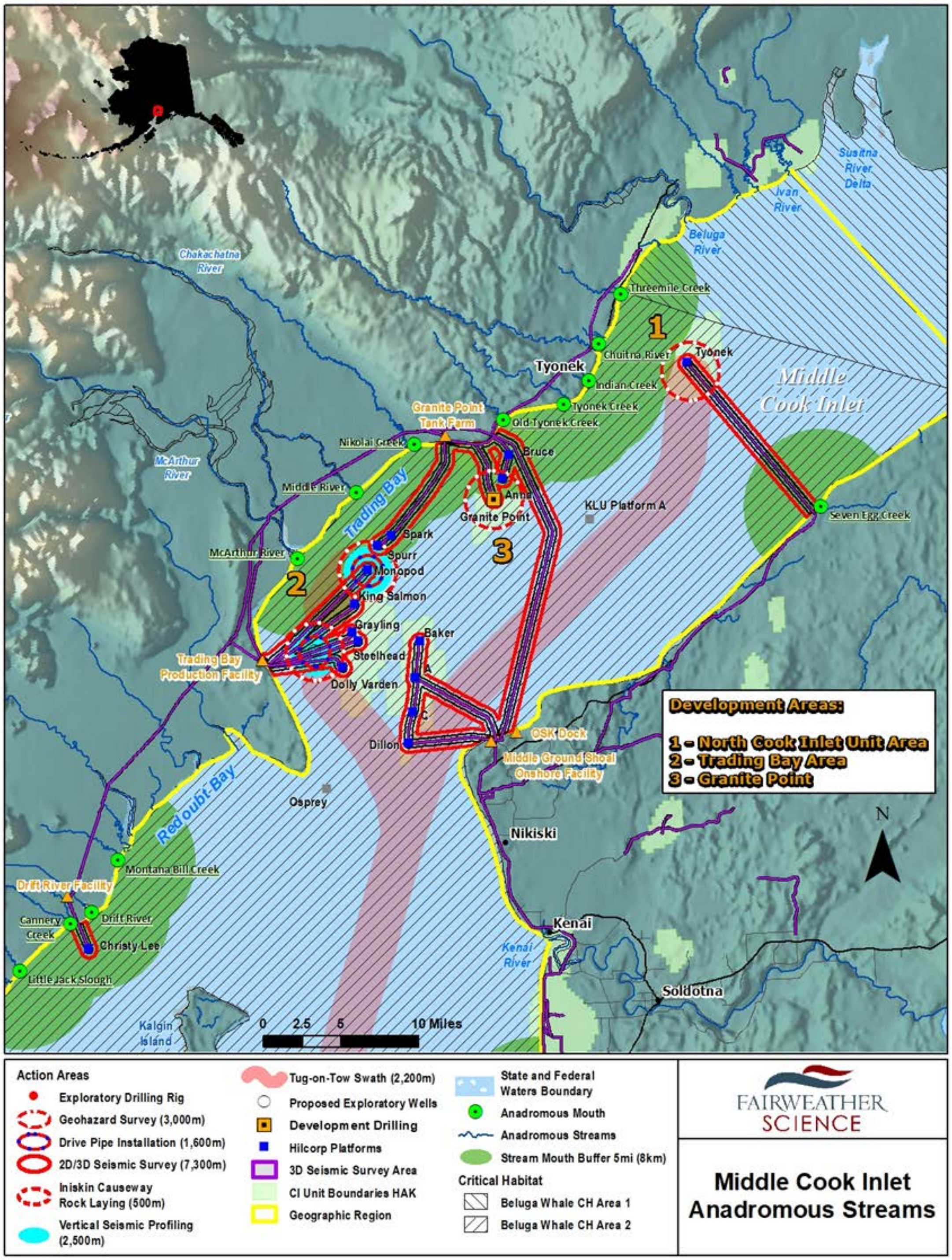

Figure 37. Physical and Biological Features (PBF) 1 intertidal and sub tidal waters of Cook Inlet with depths less than 9.1 m (30 ft; MLLW) and within 8 km (5 mi) of high and medium flow of anadromous fish streams in the middle Cook Inlet action areas. The area of PBF1 at each anadromous stream is in green.

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.

The primary impacts from the proposed action to PBF2 are from noise and unauthorized pollution (e.g., oil spills).

<u>Noise</u>

As discussed in Section 5.4.6, 6.2.2, and 6.2.3, 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. However, the limited available scientific literature indicates that noise can impact fish species physically, and also evoke a variety of behavioral responses. The noise from seismic surveys and pile driving are effects of greatest concern for PBF2.

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 (McCauley et al. 2003, Slabbekoorn et al. 2010, Casper et al. 2012, Halvorsen et al. 2012). Injury to fish depends more on the magnitude of particle motion than on sound levels as mammals perceive it (Popper and Hawkins 2019), and these effects upon fish due to seismic activity have been limited to just a few meters (Davis et al. 1998). Experimental studies indicate that pile driving associated barotrauma (i.e., damage to internal tissues) of fish occurs at sound pressure levels of 205- 215 dB re: 1 μPa_{peak} (Casper et al. 2012, Halvorsen et al. 2012), considerably greater than those expected from the pile driving activities in the proposed action. It is likely that fish will avoid sound sources within ranges that may be harmful (McCauley et al. 2003).

Noise can also have effects on the primary prey of belugas by affecting the fish's prey species. 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.

Sound pressure levels generated by other activities of the proposed action (vessel traffic, drilling, etc.) may cause temporary behavioral changes of prey species at close range, such as a startle or stress response. Project-related vessel and pipe-maintenance sounds are not expected to cause direct injury to fish, and will behaviorally affect fish only at close range, for a short period of time.

A very small proportion of primary prey species may be temporarily disturbed due to non-acoustic sources of disturbance (e.g., boat wakes, spinning propellers, divers, moving cables). They may also be disturbed during trenching operations, exhibiting a startled or flight response. These forms of disturbance would be temporary, with a geographic extent much smaller than the project action area. The risk of vessels striking prey species may exist, but vessels will be operating at speeds that will allow primary prey to avoid collisions. We expect no entanglement of prey species in project-related gear.

As discussed in Section 6.2.3, fish may respond to noise associated with the proposed action by avoiding the immediate area. However, impact of noise on beluga prey is very minor, and thus adverse effects to PBF2 will be immeasurably small. Furthermore, the probability of noise impacts on marine mammal prey occurring is very small, and thus adverse effects of project noise to PBF2 are extremely unlikely to occur. Therefore, we conclude that the adverse effects from noise impacting PBF2 are insignificant and discountable.

<u>Pollutants and Oil Spills</u>

Small unauthorized spills have the potential to affect prey species. 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 2017).

Small spills are expected to rapidly disperse due to tide-induced turbulence and mixing. We expect no project-related measurable change in primary prey in terms of prey population levels, distribution, or availability to belugas. Large and very large spills and blowouts are considered a low-probability, but high-impact event for Cook Inlet belugas and their critical habitat, including the effects of an oil spill on prey. The probability of an oil spill adversely affecting prey species is very small, and thus adverse effects to PBF2 are extremely unlikely to occur. Therefore we conclude that adverse effects from the proposed action on PBF2 are discountable.

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

As discussed in Section 6.2.6, authorized discharges of pollutants are regulated through NPDES permits which undergo separate ESA section 7 consultations (NMFS 2010b). As discussed in PBF 2 above, unauthorized spills could also occur, and while small spills are likely (see "Probability of a spill" in "Pollutants" and BOEM 2017), small spills are expected to rapidly disperse due to tide-induced turbulence and mixing. However, a large or very large oil spill or blowout is considered a low probability, high impact event.

As previously discussed in Section 6.2.6, beluga whales are thought to be vulnerable to incremental long-term accumulation of pollutants given their extreme longevity. Chronic exposure to small spills could affect individual whales within their lifetime (BOEM 2016) through accumulation of contaminants, which 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 (Geraci 1990, Geraci and St. Aubin 1990).

A large or very large spill or blowouts would have significant impacts to Cook Inlet beluga critical habitat, and PBF3 in particular. 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 2016a).

As discussed above for PBF2, small spills are expected to rapidly disperse due to tide-induced turbulence and mixing. We expect no project-related measurable change in primary prey in terms of prey population levels, distribution, or availability to belugas. Large and very large spills and blowouts are considered a low-probability, but high-impact event for Cook Inlet belugas and their critical habitat, including the effects of an oil spill on prey. The probability of an oil spill adversely affecting prey species is very small, and thus adverse effects to PBF3 are extremely unlikely to occur. Therefore we conclude that adverse effects from the proposed action on PBF3 are discountable.

PBF 4: Unrestricted passage between the critical habitat areas

PBF4 may be affected by the proposed action. Cook Inlet beluga whales are unlikely to be physically restricted from passing through critical habitat, however noise and presence of vessels and other infrastructure could cause belugas to avoid certain areas while activities are occurring. The activities with the loudest noise levels associated with this project (e.g., seismic surveys, sheet pile driving, pipe driving) will occur in the Lower Inlet where densities of belugas are low (Goetz et al. 2012). Multiple activities that will result in underwater noise will occur in the Upper Inlet within critical habitat including geohazard surveys, pipe driving, water jets, drilling, and vessel traffic. Section 6.2.1 discusses the effects of noise on belugas. Beluga avoidance of ensonified areas has the potential to restrict their passage from one critical habitat area to another, however, with the implementation of mitigation measures (e.g., shutdown zones, vessel mitigations, etc.) for these activities, the impact of project noise on beluga passage between critical habitat areas is very minor, and thus the adverse effects to PBF4 will be immeasurably small. Therefore, we conclude that the adverse effects from noise on PBF4 are insignificant.

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 2017).

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 adverse effects to PBF4 will be immeasurably small. Therefore, we conclude that the adverse effects from small oil spills on PBF4 are insignificant.

In contrast to small oil spills, large and very large oil spills are a low probability but high impact event. However, the probability of a large oil spill occurring and thus restricting beluga passage between critical habitat areas is extremely small, and thus adverse effects to PBF4 are discountable.

PBF5: Waters with in-water noise below levels resulting in abandonment of critical habitat areas by Cook Inlet Belugas

PBF5 is likely to be affected by the proposed action. Activities that will result in underwater noise that will occur in critical habitat in the Lower Inlet include 2D seismic surveys and sheet pile driving. Multiple activities that will result in underwater noise will occur in the Upper Inlet within critical habitat including geohazard surveys, pipe driving, water jets, drilling, and vessel traffic.

According to the stipulations of Lease Sale 244, of which the OCS blocks in this proposed action are part of (NMFS 2017b), 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 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. Therefore, due to the mitigation measures, the impact of project noise on PBF5 is very minor, and thus adverse effects to PBF5 will be immeasurably small. Therefore, we conclude that the adverse effects of noise on PBF5 are insignificant.

6.2.9.2 Steller Sea Lion Critical Habitat

NMFS identified physical and biological features essential for conservation of Steller sea lions in the final rule to designate critical habitat (58 FR 45269; August 27, 1993) including terrestrial, air, and aquatic habitats (as described at 50 CFR 226.202) that support reproduction, foraging, rest, and refuge. We evaluate effects to each of the physical or biological features below.

PBF1. Terrestrial zones that extend 3,000 feet (0.9 km) landward from each major haulout and major rookery in Alaska.

None of the project activities will take place inside the terrestrial zones, therefore we conclude that there will be no effect on the terrestrial zones of Steller sea lion critical habitat.

PBF2. Air zones that extend 3,000 feet (0.9 km) above the terrestrial zone of each major haulout and major rookery in Alaska.

Project aircraft are unlikely to transit near or within the air zones, therefore we conclude that there will be no effect on the air zones of Steller sea lion critical habitat.

PBF3. 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° W longitude.

No project activities will occur east of 144°W longitude, therefore we conclude that there will be no effect on the aquatic zones east of 144°W longitude.

PBF4. Aquatic zones that extend 20 nm (37 km) seaward of each major haulout and major *rookery in Alaska that is west of 144º W longitude.*

Although the action area overlaps with parts of the aquatic zones that extend 20 nm from major haulouts and rookeries, the proposed project activities will not occur within these aquatic zones. The nearest project activities will be the causeway for Iniskin Peninsula exploration project and the 3D seismic surveys located within the OCS blocks, which are more than 70 km from the boundary of the nearest aquatic zones (Table 12 and Figure 24) around five major haulouts (Ushagat/Rocks South, Ushagat/NW, Ushagat/SW, Nagahut Rocks, and Sud) and one major rookery (Sugarloaf). Noise from the activities at Iniskin and the 3D seismic surveys are expected to attenuate to ambient (120 dB) at 7.3 km, well away from the aquatic zones.

The aquatic zones will not be affected by small spills that may occur, since the spills would likely dissipate long before they would reach any of the zones. A large or very large oil spill could affect the aquatic zones, however the probability of a large or very large oil spill is very low, and thus the adverse effects to PBF4 are extremely unlikely to occur. Therefore, we conclude that the adverse effects from oil spills to PBF4 are discountable.

PBF5. 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).

Shelikof Strait is within the action area of the Hilcorp Cook Inlet oil and gas project (Figure 10 and Figure 24); however, proposed project activities will not occur within this foraging area. The nearest project activities, the causeway for Iniskin Peninsula exploration project and the 3D seismic surveys located within the OCS blocks, are approximately 120 km (~75 mi) away from the entrance to the Shelikof Strait. It is not anticipated that either vessels or aircraft associated with the project will enter Shelikof Strait.

As with the aquatic zones in PBF4, the special aquatic aquatic foraging areas will not be affected by small spills that may occur, since the spills would likely dissipate long before they would reach any of the areas. A large or very large oil spill could affect the Shelikof Strait area, however the probability of a large or very large oil spill is very low. Effects to PBF5 from a large or very large spill are extremely unlikely to occur, and thus are discountable.

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.

All of the activities described in the *Environmental Baseline* (Section 5) are expected to continue into the future. Some continuing non-Federal activities are reasonably certain to contribute to climate change within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 5).

While many of the activities (e.g., oil and gas development and coastal development) described in the *Environmental Baseline* are expected to occur into the future, these activities likely have a Federal nexus and will require ESA section 7 consultation. Activities without a Federal nexus that are expected to continue into the future include fisheries, pollution, and tourism, and are discussed in the following sections.

7.1 Fisheries (State of Alaska managed)

Fishing, a major industry in Alaska, is expected to continue in Cook Inlet. As a result, there will be continued risk to marine mammals of prey competition, ship strikes, harassment, and entanglement in fishing gear. For Cook Inlet beluga whales, there is also a notable risk of displacement from former summer foraging habitat (e.g., waters within and near the outlets of the Kenai and Kasilof Rivers during salmon season; (Figure 13; (Castellote et al. 2016)). ADF&G will continue to manage fish stocks and monitor and regulate fishing under their jurisdiction[22] in Cook Inlet to maintain sustainable stocks. It remains unknown whether and to what extent marine mammal 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.

7.2 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.

7.3 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,

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[22] https://www.adfg.alaska.gov/index.cfm?adfg=fishing.main

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 could 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. Structured observation efforts from August 10-October 9, 2018 indicate belugas presence in these waters on 12 of 22 occasions (Beluga Whale Alliance, unpublished data). 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.

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 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. If we would not expect individuals of the listed species exposed to an action's effects to experience reductions in the current or expected future survivability or reproductive success (that is, their fitness), we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (Brandon 1978, Mills and Beatty 1979, Stearns 1992, Anderson 2000). Therefore, if we conclude that individuals of the listed species are not likely to experience reductions in their fitness, we would conclude our assessment because we would not expect the effects of the action to affect the performance of the populations those individuals represent or the species those population comprise. If, however, we conclude that individuals of the listed species are likely to experience reductions in their fitness as a result of their exposure to an action, we then determine whether those reductions would reduce the viability of the population or populations the individuals represent and the "species" those populations comprise (species, subspecies, or distinct populations segments of vertebrate taxa).

As part of our risk analyses, we consider the consequences of exposing endangered or threatened species to all of the stressors associated with the proposed action, individually and cumulatively, given that the individuals in the action area for this consultation are also exposed to other stressors in the action area and elsewhere in their geographic range.

In this opinion, our analysis focused on the project activities that Hilcorp has proposed for the next five years; however, we recognize that a portion of these activities may continue into the future (e.g., 30 years). The activities that are likely to continue include the activities associated with maintenance, development, and production. There are many variables that may affect Hilcorp's future activities (e.g., whether exploratory activities will lead to new wells, whether existing platforms will continue to produce oil and gas, the price of oil and gas, etc.). Although we do not have information on Hilcorp's activities after 2024, it is likely that Hilcorp will apply for future MMPA authorization(s) which will be subject to ESA consultation. Given the lack of information we have on Hilcorp's activities from 2025 – 2055, we assume that that they will be similar to those analyzed in this opinion, and the analysis considers the potential effects from them.

8.1 Cetacean Risk Analysis

Based on the results of the *Exposure Analysis*, 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, sub-bottom profiler noise, vertical seismic profiling noise, pipe and vibratory sheet pile driving noise, and water jet noise. With the implementation of mitigation measures, exposure to vessel noise, drilling noise, well construction activity noise, aircraft noise, dynamic positioning noise, echosounders and sonar noise, hydraulic grinder noise, pinger noise, fill and rock placement noise, jack-up rig placement, sea floor disturbance, and small oil spills may occur, but the expected effects are considered insignificant and/or discountable, and are not expected to result in take. The probability of impacts on marine mammal prey occurring from the proposed project is very small, and thus adverse effects are extremely unlikely to occur. Therefore, the expected effects are considered insignificant and/or discountable. Finally, exposure to large and very large oil spills, vessel strike, unauthorized discharge, and marine debris is extremely unlikely to occur and therefore effects to listed species are considered discountable.

Our consideration of probable exposures and responses of listed whales to oil and gas exploration, development, and production activities associated with the proposed action is designed to help us assess whether those activities are likely to increase the extinction risks or jeopardize the continued existence of listed whales.

Implementation of mitigation measures in association with seismic exploration noise, sub-bottom profiler noise, vertical seismic profiling noise, pipe and vibratory sheet pile driving noise, and water jet noise would further reduce the impacts of these sounds to listed cetaceans.

Based on the annual activity scenarios provided by Hilcorp and NMFS Permits Division (Table 1; (Hilcorp 2019)), NMFS estimated the 5-year Level B take of about 58 Cook Inlet beluga whales, 18 fin whales, 1 Western North Pacific DPS humpback whale, and 11 Mexico DPS humpback whales that might result in behavioral harassment (Section 6.2.1.2). In addition, up to 2 Mexico DPS humpback whales and 5 fin whales may be exposed to Level A take during oil and gas activities in Cook Inlet. 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.

Exposure to vessel noise, drilling noise, well construction activity noise, aircraft noise, dynamic positioning noise, hydraulic grinder noise, pinger noise, sea floor disturbance, and unintentional discharge of petroleum may occur as part of the proposed action, however, with the implementation of mitigation measures, the effects are considered highly unlikely to occur or be extremely small in impact, and would not rise to the level of take. Vessel strikes are considered unlikely due to the implementation of mitigation measures. We have records of five cetaceans with vessel collisions that were reported in Cook Inlet, however, for some of the reports, the location of the strike could have occurred outside of Cook Inlet as the vessel's transit included areas outside of Cook Inlet (Section 6.2.4). 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.

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 the proposed action causing a small oil spill and exposing beluga, fin, Mexico DPS humpback, or Western North Pacific DPS humpback whales in Cook Inlet is sufficiently small as to be considered improbable.

The effects of a large oil spill would be significantly greater than that of 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 (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).

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 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 development and production activities (e.g., prescriptive and performance based regulations and guidance, as well as OCS safety and environmental protection requirements (BOEM 2012).

The hypothetical exploration and development scenario estimates a 22 percent likelihood of 1 to 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 and 40 (BOEM 2017). No VLOS is expected (the estimated probability is 10-4 to 10-5 per well; (BOEM 2016)) 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.

Although the oil and gas exploration, development, and production 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 operations or will seek alternative foraging areas. 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 markedly reduce the energy budgets of listed humpback, fin and Cook Inlet beluga 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). Their probable exposure to noise sources is 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 responses 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.

As mentioned in the *Environmental Baseline* section, Cook Inlet beluga whales, fin whales, and Western North Pacific DPS and Mexico DPS humpback whales, may be impacted by a number of anthropogenic activities present in Cook Inlet. The high degree of human activity, especially within upper Cook Inlet, has produced a number of anthropogenic risk factors that marine mammals must contend with, including: coastal and marine development, oil and gas development, ship strikes, noise pollution, water pollution, prey reduction, fisheries, tourism, direct mortalities, and research, in addition to factors operating on a larger scale such as predation, disease, and climate change. The species may be affected by multiple threats at any given time, compounding the impacts of the individual threats.

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 proposed action is 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 the proposed action 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. 2018). 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. 2018). 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 to 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 12). 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 13). Coastal development and boat traffic, 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). Seismic exploration in upper Cook Inlet has caused both Level A and Level B takes of Cook Inlet beluga whales. 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. Pollution and contaminants were listed as low relative concern for impeding the recovery of Cook Inlet beluga whales (NMFS 2016a, Muto et al. 2018). 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. 2018).

Cook Inlet belugas are undergoing an annual decline of 0.5 percent (Shelden et al. 2017). 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.

Due to the implementation of mitigation measures, including shutting down activities when beluga whales are seen at any distance, exposures to noise at received levels that could cause harassment to listed whales are expected to be minimal. Seismic operations are the loudest noise associated with the proposed action and are located in areas where belugas have been documented in low densities. Mitigation measures will reduce exposure of listed whales 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. Individuals may experience both Level A and Level B acoustic harassment, may experience masking, and may exhibit behavioral responses from project activities. Therefore, we expect ESA-listed whales may experience stress responses. If whales and sea lions are not displaced and remain in a stressful environment (i.e., within the behavioral harassment zone), we expect the stress response will dissipate shortly after the individual leaves the area or after the cessation of the acoustic stressor. TTS and PTS may occur if a listed species is within the Level B or Level A harassment zone, respectively; however, the severity of TTS and PTS depends on the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt 2013). The calculated distances to the PTS thresholds incorporate a relatively long duration, making them conservative. Although seismic exploration, sub-bottom profiler, vertical seismic profiling, pipe and vibratory sheet pile driving, and water jet activities are likely to cause 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, or social dynamics of individual whales in ways or to a degree that would reduce their fitness.

Based on the best information currently available, the proposed action is not expected to 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, we expect Western DPS Steller sea lions may experience Level A and B take through exposure to underwater noise from: seismic exploration, sub-bottom profiling, pipe and vibratory sheet pile driving, and water jetting associated with the oil and gas exploration. Exposure to vessel noise, drilling noise, well construction noise, aircraft noise, dynamic positioning noise, echosounders and sonar noise, hydraulic grinder noise, pinger noise, fill and rock placement, jack-up rig placement, seafloor disturbance, and small oil spills may occur, but such exposure would have a very small impact, and we conclude that these stressors will not result in take of sea lions. The probability of impacts on marine mammal prey occurring from the proposed project is very small, and thus adverse effects are extremely unlikely to occur. Therefore, the expected effects are considered insignificant and discountable. Exposure to large and very large oil spills, vessel strike, authorized discharge, and marine debris are considered extremely unlikely to occur. One Steller sea lion was reported 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 increase in ship traffic due to the proposed action is unlikely to change this pattern markedly due to the slow vessel speeds for project vessels. 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 associated effects from this project would be minimal. Best practices regarding waste management (cutting loops prior to disposal) will further reduce the impact of debris on Steller sea lions. Because 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 (Section 6.2.6.3).

Our consideration of probable exposures and responses of Western DPS Steller sea lions to oil and gas exploration, development, and production activities associated with the proposed action is designed to help us assess whether those activities are likely to increase the extinction risks or jeopardize the continued existence of Western DPS Steller sea lions.

Implementation of mitigation measures for seismic exploration, sub-bottom profiling, vertical seismic profiling, pipe and vibratory sheet pile driving, and water jetting will further reduce the potential impacts to Western DPS Steller sea lions.

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 2008c). While the pupping and breeding season overlaps with the proposed action activities, no Steller sea lion rookeries or haulouts are within Hilcorp's project area including the OCS blocks, 2D seismic area, Iniskin Peninsula exploratory project, although 16 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 OCS blocks, 2D seismic area and Iniskin Peninsula exploratory project, 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 measurably 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 exploration 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.

Based on the annual activity scenarios provided by Hilcorp and NMFS Permits Division (Hilcorp 2019), NMFS estimated that maximum instances of exposure to Western DPS Steller sea lions (421) that might result in behavioral harassment (Section 6.2). In addition, up to 5 Western DPS Steller sea lions may be exposed to Level A take during oil and gas activities in Cook Inlet. 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 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.

The exposure estimate is likely to be an overestimate because it assumes a uniform distribution of animals, does not account for avoidance or the effectiveness of mitigation measures in reducing take, and assumes all of the activities associated with the proposed action will be implemented. Mitigation measures will reduce exposure of Western DPS Steller sea lions 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 vessel noise, drilling noise, well construction activity noise, aircraft noise, dynamic positioning noise, hydraulic grinder noise, pinger noise, sea floor disturbance, and small oil spills may occur as part of the proposed action, however, with the implementation of mitigation measures the effects 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 the proposed action is unlikely to change this pattern markedly. In addition, the speed at which project vessels will typically be operating is below the velocity at which most lethal interactions occur. 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 associated effects from this project would be minimal. 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 (Section 6.2.6.3).

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 the proposed action causing a small oil spill and exposing Western DPS Steller sea lions is extremely small, and thus the effects are considered improbable.

Western DPS Steller sea lions occur in the action 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 NMFS aerial survey data for our exposure estimates related to components of this action because these are the best data currently available.

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, these responses are not 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 will 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. (2007a) 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. 2017), but continues to decline in more western portions of that range. 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 through 2015 (Muto et al. 2017), despite the mortality 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 and 1991. NMFS stranding database indicates an additional 1.6 Western DPS animals were killed or seriously injured per year in 2010 through 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 mentioned in the *Environmental Baseline* section, Western DPS Steller sea lions, may be impacted by a number of anthropogenic activities present in Cook Inlet. The high degree of human activity, especially within upper Cook Inlet, has produced a number of anthropogenic risk factors that marine mammals must contend with, including: coastal and marine development, oil and gas development, ship strikes, noise pollution, water pollution, prey reduction, fisheries, tourism, direct mortalities, and research, in addition to factors operating on a larger scale such as predation, disease, and climate change. The species may be affected by multiple threats at any given time, compounding the impacts of the individual threats.

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 Western DPS Steller sea lion. As a result, the proposed action is not likely to appreciably reduce the Western DPS Steller sea lion's likelihood of surviving or recovering in the wild.

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.

Based on the best information currently available, the proposed action is not expected to 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: 1) intertidal and subtidal waters of Cook Inlet with depths greater than 30 feet and within five miles of high and medium flow anadromous fish streams; 2) primary prey species; 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 critical habitat areas; and 5) 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)). The action area overlaps with Cook Inlet Beluga Critical Habitat Area 1 and 2.

Steller sea lion critical habitat includes five PBFs including: 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; and 5) 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 waters affected by project associated noise and oil contamination.

According to the final rule establishing Steller sea lion critical habitat, the primary threats that could affect the features identified as essential to the 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 the 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 (overharvesting) 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 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 in Upper Cook Inlet, where abundance and trends in salmon returns remain largely unknown.

Coastal development has resulted in both the direct loss of marine mammal habitat from construction of roads, housing or other shoreline developments, and indirect loss associated with bridges, boat traffic, in-water noise, and discharges that affect water quality. 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. Cook Inlet beluga whale and Steller sea lion critical habitat may be affected by climate change and other large-scale environmental phenomena, and can potentially affecting prey availability. Ecological regime shifts, in which species composition is restructured, have been identified in the North Pacific (Hollowed and Wooster 1992, Anderson and Piatt 1999, Hare and Mantua 2000) 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.

The proposed action 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. While noise impacts are not anticipated to result in abandonment of designated critical habitat, noise could temporarily make the habitat near the oil and gas operations less suitable to beluga whale foraging. The noise effects could last as long as the operations are underway. Oil and gas activities do not directly overlap with designated Steller sea lion critical habitat, however, noise from oil and gas operations may propagate into Steller sea lion critical habitat, and transiting vessels may overlap with Steller sea lion critical habitat aquatic zones.

According to the stipulations of Lease Sale 244, of which the OCS blocks in this proposed action are a part (NMFS 2017b), 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 LS 244 OCS blocks within Cook Inlet beluga whale critical habitat between November 1 and April 1, which provides protection during the fall and winter months when Area 2 of the critical habitat is more heavily 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. 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 percent chance of one or more large spills occurring over the life of the project (Section 6.2.6.3). No very large oil spills are expected (>10-4 to <10-5 per well frequency of occurrence) (BOEM 2017). If a large spill were to occur, it could significantly impact Cook Inlet beluga critical habitat at any time of the year by introducing toxins and other agents in amounts harmful to belugas, and/or by contaminating/destroying food resources, another essential feature. Steller sea lion haulouts, rookeries, aquatic zones, and foraging areas may also be impacted by large oil spills. However, a large oil spill would be localized to a small portion of Steller sea lion critical habitat. One large oil spill will not likely adversely modify a large portion of designated critical habitat due to the relatively small proportion of the habitat that would be impacted. Additionally, while recovery of oil after a spill is typically low (Pew Charitable Trusts 2013), the temporary nature of oil in water or ice, and cleanup and response activities is expected to reduce the risk of adverse modification of critical habitat. Cook Inlet beluga critical habitat may be exposed to a large oil spill if one were to occur, and is vulnerable year round. A large spill or VLOS could disrupt access to designated critical habitat, which is another PBF (BOEM 2017).

A small portion of designated Steller sea lion critical habitat exists within the action area and would be vulnerable to exposure to a large oil spill if one were to occur. Shelikof foraging area and Barren Islands have the highest probability (greater than 25 percent) of a large or very large oil spill from within Cook Inlet contacting them (BOEM 2017).

Depending on the size and scale of a spill, it could require multiple seasons for the essential features to return 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 2017).

A very large oil spill could affect an area extending across a major portion of Cook Inlet. The impacts to the designated critical habitat for Cook Inlet beluga whales could be at a level that reduces 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 and 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 2017). Due to the low predicted likelihood of large or VLOS, oil spills resulting from the proposed action are not likely to adversely modify designated critical habitat.

Based on likelihood, NMFS concludes that oil spills resulting from the proposed action are most likely to be small spills of refined petroleum products, however, small spills of crude oil remain possible. Small spills of refined products are expected to evaporate, weather, and dissipate to a greater extent than small volumes of spilled crude oil. However due to the ephemeral nature of small spills of refined petrolelum products, and the localized nature of small spills of crude oil, these 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 activities that are a part of the proposed action. 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 associated with the proposed action, the limited use of towing rigs, the lack of Steller sea lion critical habitat in the direct project area, the low probability of spill, the size and quality of the remaining habitat, the high tolerance of pinnipeds to oil and gas operations, the temporary impact to prey resources, and the application of mitigation measures to reduce 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 (including the likely continuation of similar activities 30 years into the future), and cumulative effects, it is NMFS's biological opinion that the proposed action is **not likely to jeopardize the continued existence of** Cook Inlet beluga whales, fin whale, Western North Pacific DPS humpback whales, Mexico DPS humpback whales, or Western DPS Steller sea lions or to destroy or adversely modify designated Cook Inlet beluga whale or Steller sea lion critical habitat.

10 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species unless there is a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (16 USC 1532(19)). "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR 402.02). Based on NMFS guidance, the term "harass" under the ESA means 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). 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)(i) and (ii)). For this consultation, we anticipate that Level A and Level B takes associated with noise exposure will occur.

Under the terms of Section 7(b)(4) and Section 7(o)(2) of the ESA, taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement (ITS).

Section 7(b)(4)(C) of the ESA provides that if an endangered or threatened marine mammal is involved, the taking must first be authorized by Section 101(a)(5) of the MMPA. Accordingly, **the terms of this incidental take statement and the exemption from Section 9 of the ESA**

become effective only upon the issuance of MMPA authorization to take the marine mammals identified here. Absent such authorization, this incidental take statement is inoperative.

The terms and conditions described below are nondiscretionary. BOEM and NMFS Permits Division have a continuing duty to regulate the activities covered by this ITS. In order to monitor the impact of incidental take, BOEM and NMFS Permits Division must monitor and must report on the progress of the action and its impact on the species as specified in the ITS (50 CFR 402.14(i)(3)). If BOEM and NMFS Permits Division (1) fail to require the authorization holder to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, and/or (2) fail to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

10.1 Amount or Extent of Take

Section 7 regulations require NMFS to estimate the number of individuals that may be taken by proposed actions or utilize a surrogate (e.g., other species, habitat, or ecological conditions) if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (50 CFR § 402.14 (i)(1)).

NMFS is reasonably certain the proposed Hilcorp and Harvest oil and gas activities in Cook Inlet, Alaska are likely to result in the incidental take of ESA-listed species by Level A and Level B harassment associated with noise from seismic surveys, sub-bottom profilers, VSP, pipe installation and pile driving, and water jets. As discussed in Section 6 of this opinion, the proposed action is expected to take the following number of ESA-listed individuals described in Table 39. For a breakdown of calculations and exposure by stressor Section 6 and Table 26 through Table 31.

The method for estimating the number of animals exposed to sound levels expected to result in Level B harassment was described in Section 6. NMFS Permits Division estimates they will authorize the following total number of Level B takes: 99 humpback whales, 18 fin whales, 58 beluga whales, and 422 Steller sea lions. Each Level B take for the 5-year period was rounded to a whole number. Of the 99 humpback whales, 10.5 percent or 11 animals are predicted to be from the Mexico DPS and 0.5 percent or 1 animal is predicted from the Western North Pacific DPS (Wade et al. 2016). Therefore, NMFS AKR is authorizing 11 Level B harassment takes for the Mexico DPS and 1 Level B harassment take for Western North Pacific DPS under the ESA.

NMFS Permits Division has estimated Level A takes of: 16 humpback whales, 5 fin whales, and 5 Steller sea lions. The proposed Level A takes for fin whales and Steller sea lions were rounded up to account for group size. Of the 16 humpback whales, 10.5 percent or 2 animals are predicted to be from the Mexico DPS and 0.5 percent or 0 animals are predicted from the Western North Pacific DPS (Wade et al. 2016). Therefore, NMFS AKR is authorizing 2 Level A takes for the Mexico DPS and 0 Level A take for Western North Pacific DPS under the ESA. Because it is not possible to identify a humpback whale by DPS in the field, NMFS AKR uses the estimated percentage of humpback whales by DPS to determine the number of listed animals that have been taken. As a result, NMFS AKR will not consider that Hilcorp has reached its ESA take limit until 99 humpback whales have been observed in a Level A or Level B zone.

Based on the above information, NMFS AKR is authorizing takes for the following number of ESA-listed individuals described in Table 39.

Table 39. Summary of incidental take of beluga whales, humpback whales, fin whales, and Steller sea lions.

Species	Type of Take	Total
Cook Inlet Beluga Whale	Level B	58
	Level A	0
Humpback Whale, Mexico DPS[1]	Level B	11
	Level A	2
Humpback Whale, Western North Pacific DPS[1]	Level B	1
	Level A	0
Fin Whale	Level B	18
	Level A	5
Steller sea lion, Western DPS	Level B	422
	Level A	5

[1] NMFS anticipates that 99 Level B takes and 16 Level A takes of humpback whales may occur. Of the total take it is expected that 10.5 percent is from the Mexico DPS and 0.5 percent is from the Western North Pacific DPS (Wade et al. 2016).

10.2 Effect of the Take

In Section 9 of this opinion, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the Cook Inlet beluga whale, Mexico DPS humpback whale, Western North Pacific DPS humpback whale, fin whale, and Western DPS Steller sea lion or destruction or adverse modification of Cook Inlet beluga whale and Steller sea lion critical habitat.

Although the biological significance of the expected behavioral responses of Cook Inlet beluga whales, fin whales, Mexico DPS humpback whales, Western North Pacific DPS humpback whales, and Western DPS Steller sea lions remains unknown, this consultation has assumed that exposure to disturbances associated with the Hilcorp oil and gas activities in Cook Inlet might disrupt one or more behavioral patterns that are essential to an individual animal's life history. However, any behavioral responses of these whales and pinnipeds to major noise sources, and any associated disruptions, are not expected to affect the reproduction, survival, or recovery of these species.

The taking of Cook Inlet beluga whales, fin whales, Mexico DPS humpback whales, Western North Pacific DPS humpback whales, and Western DPS Steller sea lions will be by incidental (acoustic) harassment only.

10.3 Reasonable and Prudent Measures (RPMs)

"Reasonable and prudent measures" are measures to minimize the amount or extent of incidental take (50 CFR 402.02). These measures are non-discretionary.

The RPMs included below, along with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. NMFS concludes that the following RPMs are necessary and appropriate to minimize or to monitor the incidental take of Cook Inlet beluga whales, fin whales, Mexico DPS humpback whales, Western North Pacific DPS humpback whales, and Western DPS Steller sea lions resulting from the proposed action.

1. This ITS is valid only for the activities described in this biological opinion, and which have been authorized under section 101(a)(5) of the MMPA.
2. The taking of ESA-listed species not authorized under the ITS and MMPA, such as serious injury or death, may result in the modification, suspension, or revocation of the ITS.
3. BOEM, NMFS Permits Division, and Hilcorp must implement and monitor the effectiveness of mitigation measures incorporated as part of the proposed authorization for the incidental taking of ESA-listed marine mammals pursuant to section 101(a)(5)(D) of the MMPA. In addition, they must submit a report to NMFS AKR that evaluates the mitigation measures and reports the results of the monitoring program.

10.4 Terms and Conditions

"Terms and conditions" implement the reasonable and prudent measures (50 CFR 402.14). These must be carried out for the exemption in section 7(o)(2) to apply.

In order to be exempt from the prohibitions of section 9 of the ESA, the NMFS Permits Division, BOEM, and Hilcorp must comply with the following terms and conditions, which implement the RPMs described above and the mitigation measures set forth in Section 2.1.2 of this opinion. The NMFS Permits Division, BOEM, and Hilcorp have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14).

Partial compliance with these terms and conditions may result in more take than anticipated, and may invalidate this take exemption. These terms and conditions constitute no more than a minor change to the proposed action because they are consistent with the basic design of the proposed action.

To carry out RPM #1, NMFS Permits Division, BOEM or Hilcorp must undertake the following:

A. Any take must be authorized by a valid, current, LOA/IHA issued by NMFS under section 101(a)(5) of the MMPA, and such take must occur in compliance with all terms, conditions, and requirements included in such authorizations and with this Opinion and this ITS.

To carry out RPM #2, NMFS Permits Division, BOEM or Hilcorp must undertake the following:

A. The taking of any marine mammal in a manner other than that described in this biological opinion and ITS must be reported within 24 hours to NMFS AKR, Protected Resources Division at 907-586-7638.

B. In the event that the proposed action causes unauthorized take of a marine mammal that results in a serious injury[23] or mortality, the applicant shall immediately cease operations associated with the activity that resulted in the serious injury or mortality, and immediately report the incident to NMFS AKR, Protected Resources Division at 907-586-7638 to jon.kurland@noaa.gov, to the Marine Mammal Stranding Hotline at 877-925-7773, and to NMFS Permitting Division (Sara Young, sara.young@noaa.gov or 301-427-8484). Curtailing of activities shall be done with consideration of human, property, and environmental safety. The report must include the following information: (i) Time, date, and location (latitude/longitude) of the incident; (ii) details on the nature and cause of the take (e.g., vehicles, vessels, and equipment in use at the time of take); (iii) an account of all known sound sources above 120 dB that occurred in the 24 hours preceding the incident; (iv) water depth at the location of the take; (v) environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility); (vi) description of marine mammal observations in the 24 hours preceding the incident; (vii) species identification or description of the animal(s) involved; (viii) the fate of the animal(s); (ix) and any photographs or video footage of the animal obtained.

   Activities that may have caused the take must cease upon the occurrence of unauthorized take, and must not resume until NMFS is able to review the circumstances of the prohibited take. NMFS Permits Division or BOEM must work with NMFS AKR and the applicant to determine what is necessary to minimize the likelihood of additional prohibited take and ensure ESA compliance. The applicant must not resume the suspended activity, except in protection of safety as above, until notified by NMFS via letter, email, or telephone.

C. In the event that an oiled ESA-listed marine mammal is spotted, the lessees or permittees must report the incident within 24 hours to NMFS AKR, Protected Resources Division at 907-586-7638, to jon.kurland@noaa.gov, alicia.bishop@noaa.gov, the Marine Mammal Stranding Hotline at 877-925-7773, and to NMFS Permitting Division Jaclyn Daly 301-427-8438.

To carry out RPM #3, NMFS Permits Division, BOEM, or Hilcorp must undertake the following:

A. In the event that an operator reaches, or appears likely to exceed, the limit on annual take authorized for any specific activity as described in this ITS, BOEM or its designee must contact the Assistant Regional Administrator, Protected Resources Division, NMFS, Juneau office at 907-586-7638, and/or by email to jon.kurland@noaa.gov, and NMFS Permitting Division at 301-427-8484, and email sara.young@noaa.gov. NMFS AKR will work with NMFS Permit Division and BOEM and the operator to determine what is necessary to minimize the likelihood of further take, and determine if reinitiation of consultation is warranted (50 CFR 402.16).

B. BOEM must submit to NMFS an annual report summarizing ESA-listed marine mammal

[23] Serious injury means "any injury that will likely result in mortality" (50 CFR 216.3).

sightings and annual takes of listed marine mammals. The annual report will be submitted within 90 days of the cessation of in-water work each year. The draft annual report will be subject to review and comment by NMFS AKR. Comments and recommendations made by NMFS AKR must be addressed in the annual report prior to NMFS acceptance of the annual report. The draft report will be considered final for the activities described in this opinion if NMFS AKR has not provided comments and recommendations within 30 days of receipt of the draft report. This annual report must contain the following information:

1. A description of the implementation and qualitative assessment of the effectiveness of mitigation measures for minimizing adverse effects of the action on ESA-listed species;
2. Lessons learned and recommendations for improvement of mitigation measures and monitoring techniques; and
3. A digital file that can be queried containing all observer monitoring data and associated metadata.

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).

In order to keep NMFS's Protected Resources Division informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS Permits Division and BOEM should notify NMFS AKR of any conservation recommendations they implement in their final action.

NMFS AKR recommends that Hilcorp funds project(s) beneficial to marine mammal prey species. Potential projects related to salmon habitat restoration and elodea eradication and pike suppression are listed below.

1. **<u>Salmon Habitat Restoration Needs</u>:** Salmon populations in Cook Inlet have been in decline for the last several years, with 2012 and 2013 suffering record lows. These marked declines have continued with the 2016 Alaska Department of Fish and Game (ADF&G) harvest estimate being 19 percent less than the recent 10-year average annual harvest. Specifically, Chinook salmon numbers have been so low that commercial and subsistence fisheries have been closed. This is also a concern for the beluga whale population as salmon are documented as being an important food source during summer months.

   In order to find food and cover, juvenile and adult fish including salmon need to move between a variety of habitats including streams, wetlands, lakes, sloughs, large rivers, side channels, estuaries, and ocean. Barriers to fish passage, such as undersized road culverts and dams, can change habitat and can delay or block fish from accessing habitats and food sources at critical times of the year. In the state of Alaska, several federal, state, tribal, and other entities have partnered to identify, assess, and remove barriers to fish passage. ADF&G has inventoried culverts in many parts of the state to determine potential fish passage barriers. Based on a recent ADF&G inventory in 2016 of the culverts in Tyonek and the surrounding areas, the majority of these culverts represent full or partial barriers to upstream and downstream migration of adult and juvenile anadromous fish.

Fish passage barriers, including culverts and dams, were introduced to the Tyonek area and western Cook Inlet in the 1960's when logging and oil and gas development began in the area. Oil companies built access roads to oil pads and wells and logging companies built access roads to timber, each of which required culverts to cross streams and lake outlets. Many of these roads were built quickly and did not accurately consider fish passage, leading to poorly installed or undersized culverts, a common fish passage barrier. Oil development in the region has been in decline for the last decade and many oil pads sit abandoned, however the roads and culverts remain. Despite the disuse of these roads for their intended purpose, many have become thoroughfares for hunting, firewood collection, and transportation between communities.

The Native Village of Tyonek, the nearest community to most proposed project sites, is a remote Dena'ina Athabascan village located 43 miles southwest of Anchorage. This community is considered to be 'off the road system': although there are roads within the area, the only way to reach Tyonek from Anchorage and other Alaskan communities is by boat or plane. Tyonek has long been home to the Tebughna, or "Beach People," and today includes about 190 residents. Salmon is a primary subsistence resource for Tyonek and beluga has been an important food source in the past when hunting was premitted. The District contains over 30 culverts on key river systems with the majority defined as impassable.

In 2012, Tyonek Tribal Conservation District (TTCD) identified three priority culvert replacements and worked with partners to complete these culvert replacements between 2012 and 2015. In 2016, TTCD worked with local community members, landowners, US Fish & Wildlife Service, and Alaska Department of Fish & Game to develop a fish passage improvement prioritization plan to address all remaining barriers to anadromous fish within the area. The projects listed below represent the top priority salmon habitat restoration projects from this prioritization plan. They are presented in order of priority.

Project: Indian Creek Crossing Culvert Replacement

Habitat Blocked: 2.4 upstream miles, 27.7 lake acres.

Cost Estimate: $427,609

Species: Coho, Pink

Description: This culvert was replaced in 2012 by TTCD and USFWS, prior to updates to hydrology data for the area. Recent surveys have shown that the current capacity is too low. In 2019, USFWS completed designs to add an overflow culvert and complete substrate repair at this site. All permit applications for this project have been submitted.

Project: Old Tyonek Creek Culvert Replacement

Habitat Blocked: 0.8 upstream miles, 32 lake acres

Cost Estimate: $500,000

Species: Coho, Chinook, Pink, Eulachon

Description: In 2018, TTCD contracted the Boutet Company to complete designs to address this barrier to salmon movement. Designs and permitting for this project should be completed by the end of 2019, enabling TTCD to bid this project for construction in 2020.

Project: Unnamed Creek in Old Tyonek Creek Watershed Culvert Removal

Habitat Blocked: 1 upstream mile, 78.7 lake acres

Cost Estimate: $50,000

Species: Coho, Pink, Eulachon

Description: The culvert at this site is partially washed out and blocks fish passage. The road is rarely used and primarily used by ATVs for subsistence activities. The goal at this site is to remove the culvert and construct a low water crossing for ATV use.

Project: Unnamed Creek in Old Tyonek Creek Watershed Culvert Removal

Habitat Blocked: 0.1 upstream mile, 0.7 lake acres

Cost Estimate: $50,000

Species: Coho, Pink, Eulachon

Description: The culvert at this site is partially washed out and blocks fish passage. The road is rarely used and primarily used by ATVs for subsistence activities. The goal at this site is to remove the culvert and construct a low water crossing for ATV use.

Project: Unnamed Tribuary to Indian Creek Culvert Replacement

Habitat Blocked: 1 upstream mile, 0 lake acres

Species: Coho, Pink

Description: This culvert is a barrier to juvenile salmon and is located on the road to the Tyonek Cemetery. The goal at this site is to replace the current barrier with a fish friendly culvert.

Project: Bird Lake Outlet Culvert Replacement

Habitat Blocked: 0.1 upstream mile, 95.8 lake acres

Species: Coho

Description: This culvert is a barrier to adult salmon. The goal at this site is to replace the current barrier with a fish friendly culvert.

Project: Chuitbuna Lake Outlet Culvert Replacement

Habitat Blocked: 0.1 upstream mile, 116 lake acres

Species: Coho

Description: This culvert is a barrier to juvenile salmon. The goal at this site is to replace the current barrier with a fish friendly culvert.

2. **Elodea Eradication and Pike Suppression projects that will benefit salmon and belugas in upper watersheds of Cook Inlet:** Invasive Elodea and Pike in the freshwater systems feeding into Cook Inlet are a concern for freshwater productivity of salmon, a forage fish for Cook Inlet Beluga whale. Elodea and Pike control are a priority strategy for the Mat-Su and Kenai Fish Habitat Partnerships. These partnerships and their strategic plans focus on reducing threats to salmon.

   Pike: While northern pike (*Esox lucius*) are native north and west of the Alaska Range, they are an introduced species to the Mat-Su Basin, where they are voracious predators of juvenile salmon and other native resident fish. Impacts of northern pike predation on native fish populations can be devastating where their habitats overlap. Northern pike prefer cold shallow freshwaters and are saltwater tolerant when salinities are low. They spawn in marshy areas with shallow water, emergent vegetation, and mud bottoms covered with mats of aquatic vegetation. Northern pike have direct impacts on salmon populations and indirect impacts on ecosystem health through decreasing biodiversity, removing salmon as a food source for predators like belugas, and reducing transfer of marine-derived nutrients to terrestrial ecosystems through decaying salmon carcasses. The potential threat of northern pike is greatest for Chinook and Coho salmon due to a preference for similar habitats. Coho salmon also have a high vulnerability to northern pike predation because they rear in eutrophic lakes, ponds, sloughs, and other preferred pike habitat. Several Chinook salmon systems have been severely impacted by northern pike predation. In 2007 one of the most popular Chinook salmon streams - Alexander Creek in the Susitna Valley - was closed to Chinook salmon fishing by the Alaska Board of Fisheries because northern pike reduced the Chinook salmon population to an unsustainable level. (Mat-Su Strategic Plan).

   Elodea: Elodea is an invasive submerged aquatic plant which survives under ice. When introduced to a new waterway, Elodea grows rapidly, overtaking native plants, filling the water column, and changing the habitat conditions to which native fish are adapted. Thick mats form at or just below the water surface and can increase habitat quality for predatory northern pike, further exacerbating the impacts of pike predation on juvenile salmon and other fish. Additionally, Elodea can reduce salmon spawning and rearing habitat and compromise the long-term health of Alaska's salmon stocks, through changes in water flow regimes and providing cover for piscavores.

Elodea and pike detection and treatment is ongoing in Cook Inlet. Projects can range in cost and area restored. Restoration undertaken in this capacity should be coordinated with NOAA Restoration Center for appropriate mitigation scaling and current priority needs.

Fish habitat strategic plans can be found at: Kenai Fish habitat Strategic Plan https://www.kenaifishpartnership.org/wp-content/uploads/2013/06/DRAFT-Freshwater-CAP_2014_solicitation.pdf

Mat-Su Fish Habitat Strategic Plan: https://www.matsusalmon.org/resources/strategic-planning-documents/

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, 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 Permits Division, BOEM, 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 402.01 et seq.

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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