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

Liberty Oil and Gas Development and Production Plan Activities, Beaufort Sea, Alaska

NMFS Consultation Number: AKRO-2019-00004 (Previously AKR-2018-9747)

Action Agencies: National Marine Fisheries Service (NOAA), Office of Protected Resources, Permits and Conservation Division; Bureau of Ocean Energy Management (BOEM); Bureau of Safety and Environmental Enforcement (BSEE); Environmental Protection Agency (EPA); and the U.S. Army Corps of Engineers (USACE)

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?
Bowhead Whale (*Balaena mysticetus*)	Endangered	Yes	No	N/A
Blue whale (*Balaenoptera musculus*)	Endangered	No	No	N/A
Fin Whale (*Balaenoptera physalus*)	Endangered	No	No	N/A
Humpback Whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	No	No	N/A
Humpback Whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	No	No	N/A
North Pacific Right Whale (*Eubalaena japonica*)	Endangered	No	No	No
Sperm Whale (*Physeter macrocephalus*)	Endangered	No	No	N/A
Ringed Seal, Arctic Subspecies (*Phoca hispida hispida*)	Threatened	Yes	No	N/A
Bearded Seal, Beringia DPS (*Erignathus barbatus nauticus*)	Threatened	Yes	No	N/A
Steller Sea Lion, Western DPS (*Eumatopias jubatus*)	Endangered	No	No	No

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By:

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

Date: August 30, 2019

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TERMS AND ABBREVIATIONS

µPa	Micro Pascal
2D	Two-Dimensional
3D	Three-Dimensional
Ac	Acre
ACIA	Arctic Climate Impact Assessment
ADNR	Alaska Department of Natural Resources
AEWC	Alaska Eskimo Whaling Commission
AGL	Above Ground Level
AKR	Alaska Region
APD	Application for Permit to Drill
ARBO	Arctic Regional Biological Opinion
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASL	Above Sea Level
ASLC	Alaska SeaLife Center
ATOC	Acoustic Thermometry of the Ocean Climate
BA	Biological Assessment
Bbbl	Billion Barrels
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOSS	Bering Sea and Okhotsk Seas
BPXA	BP Exploration Alaska
BSAI	Bering Sea/Aleutian Island
BSEE	Bureau of Safety and Environmental Enforcement
BWASP	Bowhead Whale Feeding Ecology Study
CAA	Conflict Avoidance Agreement
CHIRP	Compressed High Intensity Radar Pulse
CI	Confidence Interval
CNP	Central North Pacific
CPUE	Catch Per Unit Effort
CSEL	Cumulative Sound Exposure Level
CSEM	Controlled Source Electromagnetic
CSESP	Chukchi Sea Environmental Studies Program
Cui	Cubic Inches
CV	Coefficient of Varience
CWA	Clean Water Act
dB re 1µPa	Decibel referenced 1 microPascal
DDT	Dichloro-Diphenyltrichloroethane
District Court	U.S. District Court for the District of Alaska
DMLW	Division of Mining, Land, and Water
DP	Dynamic Positioning
DPP	Development and Production Plan
DPS	Distinct Population Segment
DWH	Deepwater Horizon
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EP	Exploration Plan

EPA	Environmental Protection Agency
ERL	Effects Range Low
ERM	Effects Range Medium
ESA	Endangered Species Act
EZ	Exclusion Zone
°F	Fahrenheit
FAA	Federal Aviation Administration
Ft	Feet
FWS	U.S. Fish and Wildlife Service
G&G	Geological & Geophysical
Gal	Gallons
Hilcorp Alaska, LLC	Hilcorp
Hz	Hertz
ICS	Incident Command System
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITL	Information to Lessee
ITS	Incidental Take Statement
IWC	International Whaling Commission
Km	Kilometers
Kn	Knot
km^2	Square Kilometers
L	Liters
LDPI	Liberty Development and Production Island
LS 193	Lease Sale 193
M	Meter
Mi	Mile
Ms	Milliseconds
MLC	Mudline Cellar
MLC-ROV	Mudline Cellar Remotely Operated Vehicle
MMbbl	Million Barrels
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MODU	Mobile Offshore Drilling Unit
MONM	Marine Operations Noise Model
MWCS	Marine Well Containment System
NEPA	National Environmental Policy Act
Ninth Circuit	U.S. Court of Appeals for the Ninth Circuit
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NTL	Notice to Lessee
OBC	Ocean Bottom Cable
OC	Organochlorine
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
Opinion	Biological Opinion
OSR	Oil Spill Response
OSRA	Oil Spill Risk Analysis
OSRO	Oil Spill Response Organization

OSRV	Oil Spill Response Vessel
OST	Oil Supply Tanker
OSV	Offshore Supply Vessels
OWRO	Oiled Wildlife Response Organization
PAH	Polycyclic Aromatic Hydrocarbons
PBDE	Polybrominated Diphenyl
PBR	Potential Biological Removal
PBU	Prudhoe Bay Unit
PCB	Polychlorinated Biphenyls
PCE	Primary Constituent Element
Permits Division	NMFS Office of Protected Resources, Permits and Conservation Division
psi	Pound Per Square Inch
PSO	Protected Species Observers
PTS	Permanent Threshold Shift
$R_{95\%}$	Radius of a Circle Encompassing 95% of the Area of the Contour
R_{ea}	Radius of a Circle with Area Equivalent to the Total Area of the Contour
R_{max}	Maximum Distance from Sound Source to the Contour
rms	Root Mean Square
ROW	Right of Way
RP	Responsible Party
RPA	Reasonable Prudent Alternative
RSC	Regional Stranding Coordinator
SA	Stranding Agreement
SAE	SAExploration, Inc.
SDI	Satellite Drilling Island
SDR	Satellite Data Recorder
SEIS	Supplemental Environmental Impact Statement
SONAR	Sound Navigation and Ranging
SPL	Sound Pressure Level
SPLASH	Structure of Populations, Levels of Abundance and Status of Humpback Whales
TAPS	Trans-Alaska Pipeline System
TGS	TGS-Nopec Geophysical Company ASA
TTS	Temporary Threshold Shift
UAS	Unmanned Aircraft System
uERD	Ultra Extended Reach Drilling
USACE	U.S. Army Corps of Engineers
USDOI	United States Department of Interior
USFWS	United States Fish and Wildlife Service
VLOS	Very Large Oil Spill
VMS	Vessel Monitoring System
VSP	Vertical Seismic Profiling
WNP	Western North Pacific

1 INTRODUCTION

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

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) of the ESA requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking, specifies those reasonable and prudent measures necessary or appropriate to minimize such impact, and sets forth terms and conditions to implement those measures.

For the actions described in this document, the action agencies are the NMFS, Office of Protected Resources, Permits and Conservation Division (Permits Division); U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE); Environmental Protection Agency (EPA); and the U.S. Army Corps of Engineers (USACE). The latter four agencies propose to authorize Hilcorp Alaska, LLC (Hilcorp) to conduct oil and gas development, production, and decommissioning activities and ensure compliance with the terms and conditions of these activities for the Liberty Development and Production Project (Liberty Project) in the Beaufort Sea under the Outer Continental Shelf (OCS) Lands Act over a 25-year period beginning in December 2020 through November 2045. The NMFS Permits Division proposes to authorize Hilcorp to incidentally take marine mammals under the Marine Mammal Protection Act (MMPA) in association with the Liberty Project. 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 proposed action on endangered and threatened species and designated critical habitats.

The opinion and ITS were prepared by NMFS in accordance with section 7(b) of the ESA (16 U.S.C. 1531-1544), and implementing regulations at 50 CFR part 402.

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

Background

This opinion considers the effects of the authorization of oil and gas exploration activities for the Liberty Project from December 2020 to November 2045. These actions have the potential to affect the endangered bowhead whale (*Balaena mysticetus*), endangered blue whale (*Balaenoptera musculus*), endangered fin whale (*Balaenoptera physalus*), endangered Western North Pacific distinct population segment (DPS) humpback whale (*Megaptera novaeangliae*), threatened Mexico DPS humpback whale (*Megaptera novaeangliae*), endangered North Pacific right whale (*Eubalaena japonica*), endangered sperm whale (*Physeter macrocephalus*), endangered Western DPS Steller sea lion (*Eumatopias jubatus*), threatened Arctic subspecies of ringed seal (*Phoca hispida hispida*), and threatened Beringia DPS bearded seal (*Erignathus barbatus nauticus*), and designated critical habitats for North Pacific right whales and Steller sea lions. BOEM determined there would be no effect to Western North Pacific DPS endangered gray whales (*Eschrichtius robustus*).

This opinion is based on information provided in the May 2017 Development and Production Plan (DPP) Amendment 3 (Hilcorp 2017); December 2017 Biological Assessment (BOEM 2017a); July 2017 Draft and 2018 Final Environmental Impact Statement (EIS) on the Effects of Oil and Gas Activities associated with the Liberty Development and Production Plan in the Beaufort Sea, Alaska (EIS; BOEM 2017b, 2018c); February 2018 Petition to NMFS Office of Protected Resources, Permits and Conservation Division (Permits Division) for Promulgation of Regulations and Request for Letter of Authorization Pursuant to Section 101(a)(5)(A) of the Marine Mammal Protection Act for the Taking of Marine Mammals Incidental to Construction and Installation of the Liberty Drilling and Production Island (Request for Incidental Take Authorization) (Hilcorp 2018a); NMFS Permits Division proposed rule (84 FR 24926; 84 FR 32697); project proposals; clarifying email and telephone conversations between NMFS and BOEM staff; an assumptions matrix; and other sources of information. A complete record of this consultation is on file at NMFS's Juneau, Alaska office.

1.1.1 Liberty Project History

The Liberty prospect (also termed field) has been subject to several proposed project designs, National Environmental Policy Act (NEPA) reviews, and consultations since its discovery over 30 years ago. The leases associated with the Liberty Unit (for which Hilcorp is the designated operator) were attained under Lease Sales 124 (in 1991), 144 (in 1996), and 202 (in 2007). The Liberty Reservoir was first discovered by Shell Oil Company. Shell drilled four wells between 1982 and 1987 to evaluate the potential of the Kekiktuk Formation in Foggy Island Bay. Three of the wells were drilled from Tern Island, which Shell constructed in 1981 and 1982. The fourth well was drilled from Goose Island, located southeast of Tern Island. From 1996 through 1997, BP Exploration Alaska (BPXA) drilled the Liberty No. 1 exploration well. The surface location for this well was a gravel and ice structure situated on top of the Tern Island, which is currently abandoned and eroding (as planned).

Based on BPXA's interpretation of geologic data, seismic data, and well tests, in 1997 BPXA estimated the Liberty prospect contains 120 million barrels (MMbbl) of recoverable reserves (BOEM 2017b). Since then, plans to develop the field have progressed through three stages, as described below.

1998-2002 Plans – In February 1998, BPXA submitted a DPP to BOEM and BSEE's precursor agency, the Minerals Management Service (MMS), for a project that included a man-made gravel island, on-island processing facilities, and a buried, single-wall subsea pipeline to shore and tie-in to the existing Badami pipeline.

MMS commenced preparation of an EIS. Prior to a final decision in the NEPA process, BPXA requested that the project be placed on hold, and MMS granted a Suspension of Production in July 2001. MMS issued a final EIS on this DPP in May 2002, but did not issue a Record of Decision.

2002-2012 Plans – From 2002 to 2005, BPXA evaluated alternative ways to develop the oil at the Liberty site. In August 2005, BPXA proposed to access the Liberty Reservoir with ultra-extended-reach drilling (uERD) from the existing Satellite Drilling Island (SDI) on the Endicott causeway. The proposed land-based project was intended to address concerns raised during the 2002 EIS process regarding the impacts of construction of a new gravel island and subsea pipeline. In April 2007, BPXA submitted a new Liberty DPP. BOEM prepared an Environmental Assessment, and issued a Finding of No Significant Impact in November 2007. Following approval of the 2007 DPP, BPXA expanded the Endicott SDI and constructed and positioned a drilling rig to drill the proposed wells. However, BPXA cancelled the uERD project in 2012 due to technical difficulties. The uERD approach has since been abandoned, and BPXA has planned the decommissioning and removal of the drill rig from SDI.

2012-2017 Plans – In 2012, BPXA began re-evaluating ways to develop the leases with construction of an off-shore island over the reservoir and conventional drilling technology. In April 2014, BPXA announced the sale of several of its North Slope holdings to Hilcorp including Northstar, Endicott, Milne Point, and Liberty. Full operatorship and 50 percent ownership of the Liberty field was transferred from BPXA to Hilcorp in late 2014. Hilcorp submitted a DPP for Liberty in December 30, 2014. Hilcorp incorporated many of the concepts of the plan outlined in the 1998 BPXA DPP into its DPP, including a man-made gravel island, on-island processing facilities, and a buried, subsea pipeline to shore and tie-in to the Badami pipeline. BOEM made several requests for additional information on the DPP throughout the winter, spring, and summer of 2015. Hilcorp responded to these requests with a plan revision on September 8, 2015. BOEM deemed the DPP complete on September 18, 2015. The DPP was subsequently amended on March 15, 2017, and May 26, 2017.

Consultation History

- **October 27, 2017:** NMFS Alaska Region (AKR) received a request from BOEM as the lead action agency and on behalf of BSEE, EPA, and USACE to initiate formal consultation under Section 7 of the ESA and a Biological Assessment (BOEM 2017a).
- **November 21, 2017**: NMFS AKR provided a 30-day response letter to BOEM indicating that the initiation package BOEM submitted was insufficient for NMFS to initiate formal consultation and requested additional information be provided.
- **December 22, 2017:** BOEM provided a response and an updated Biological Assessment to NMFS AKR. However, the updated Biological Assessment did not fully address NMFS's information requests or clarify discrepancies associated with the proposed action.
- **January 10, 2018**: NMFS AKR and NMFS Permits Division met with BOEM to discuss the revisions made to the Biological Assessment. BOEM staff indicated that the information still needed by NMFS may be presented by the applicant in an updated MMPA Request for Incidental Take Authorization.
- **January 19, 2018**: NMFS AKR sent BOEM a second 30-day response letter highlighting remaining information that NMFS needed.
- **January 25, 2018:** Hilcorp submitted to NMFS Permit Division an updated MMPA Request

for Incidental Take Authorization. NMFS AKR subsequently reviewed the application and determined it contradicted information provided in the action agencies' initiation package.

- **February 13, 2018:** Due to discrepancies between project documents, NMFS (AKR and Permits Division), BOEM, and Hilcorp met to review and discuss the assumptions NMFS would use to move forward with initiating formal consultation.
- **February 21, 2018**: NMFS, BOEM, and Hilcorp agreed the assumptions matrix discussed during the February 13, 2018, meeting accurately portrayed the proposed action and should be used for the formal consultation. NMFS deemed BOEM, BSEE, EPA, and USACE's initiation package complete and initiated consultation on the Liberty Project.
- **April 4, 2018**: Hilcorp submitted a revised MMPA Request for Incidental Take Authorization.
- **June 1, 2018**: NMFS AKR submitted a letter to BOEM requesting additional information regarding on-ice activities associated with the proposed action; analysis of effects for on-ice activities on ice seals; and best management practices to avoid and minimize adverse impacts of on-ice activities on ice seals. This request was submitted in response to two separate incidents in April involving ringed seal disturbance and habitat modification in conjunction with ice road and ice trail activities associated with North Slope oil and gas activities similar to those being proposed for the Liberty Project (NMFS 2018a).
- **June 22, 2018**: BOEM responded to the NMFS AKR additional information request regarding on-ice activities (BOEM 2018b).
- **June 29, 2018**: NMFS Alaska Region provided BOEM, BSEE, EPA, USACE, and Hilcorp with a copy of the draft biological opinion on the suite of activities that would be permitted by the action agencies. Comments were due July 9, 2019.
- **July 6, 2018**: EPA submitted comments on the draft opinion.
- **July 9, 2018**: Hilcorp submitted comments on the draft opinion.
- **July 12, 2018**: BOEM and BSEE submitted comments on the draft opinion.
- **July 31, 2018:** NMFS AKR finalized and signed the opinion.
- **February 8, 2019:** NMFS AKR received a request from NMFS Permits Division to initiate formal consultation under Section 7 of the ESA. NMFS identified the following changes to the proposed action: the addition of 700 to 1,000 foundation piles, sheet pile driving in the transition area of the pipeline from the sea floor to tundra, updated density information, and resulting changes in the take requested.
- **March 6, 2019:** NMFS AKR requested additional information from NMFS Permits Division.
- **April 8, 2019:** NMFS Permits Division provided the additional information, and NMFS AKR initiated formal consultation.
- **July 19, 2019**: BOEM, as the lead action agency and on behalf of BSEE, EPA, and USACE, requested reinitiation based on updates to the project description (i.e., foundation piles and sheet pile driving) and updates to the requested take numbers.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

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).

This opinion considers the effects of NMFS Permits Division's, BOEM's, BSEE's, EPA's, and USACE's respective authorizations relating to oil and gas development, production, and decommissioning activities for the Liberty Project. The activities comprising the proposed action are further described below.

Chapter 2 of this opinion summarizes the proposed action and associated activities. Additional information can be found in the following documents:

- Biological Assessment – Liberty Development and Production Plan (BOEM 2017a)
- Petition for Promulgation of Regulations and Request for Letter of Authorization Pursuant to Section 101(a)(5)(A) of the Marine Mammal Protection Act for the Taking of Marine Mammals Incidental to Construction and Installation of the Liberty Drilling and Production Island (Hilcorp 2018a)
- Liberty Development Project – Development and Production Plan, Amendment 3 (Hilcorp 2017)
- Liberty Development Project – Draft and Final Environmental Impact Statement (BOEM 2017b, 2018c)
- NMFS Proposed Rule to authorize take under the MMPA (84 FR 24926; 84 FR 32697)

2.1.1 Proposed Activities

The proposed action analyzed in this opinion is the development, production, operation, and decommissioning of the Liberty Drilling and Production Island (LDPI) in Foggy Island Bay of the Beaufort Sea (Figure 1). Foggy Island Bay is located within Stefansson Sound, and the Liberty Unit will be built landward of the barrier island. The LDPI will include a self-contained offshore drilling and production facility located on an artificial gravel island with a subsea pipeline to shore. The LDPI will be located approximately 8 kilometers (km) or 5 miles (mi) offshore in Foggy Island Bay and 11.7 km (7.3 mi) southeast of the existing SDI on the Endicott causeway. The proposed LDPI location is shown in Figure 1. The LDPI will be constructed of reinforced gravel in 5.8 meters (m) or 19 feet (ft) of water and have a working surface of approximately 3.8 hectares (ha) or 9.3 acres (ac).

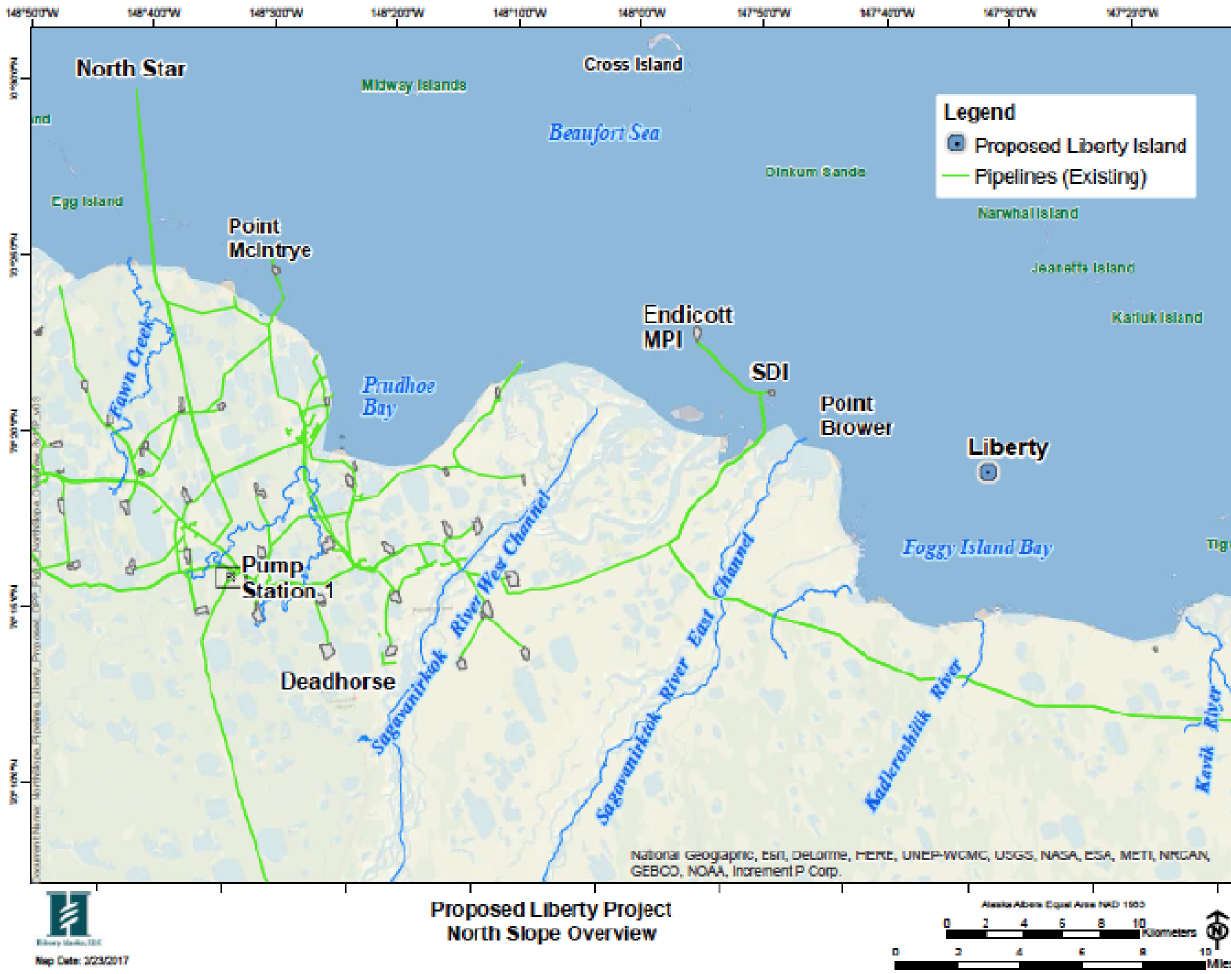


Figure 1. Location of Liberty Project on the Alaska North Slope (Hilcorp 2018a).

Project Phases

The Liberty Project is comprised of four phases: (1) construction (years 1-4); (2) drilling (years 3-23); (3) production (years 5-23); and (4) decommissioning (years 24-25). The Project is anticipated to begin in December of 2020 with construction of ice roads to support the installation of the LDPI. Table 1 outlines the general timeline for each phase, and associated activities. Additional information on each of these activities can be found in Sections 2.1.1.1 through 2.1.1.7.

Table 1. Liberty Project timeline.

Phase	Activity[1]	Project Years
Construction	Island construction	1[2]
	Pipeline installation	2
	Facility construction	2
Drilling	Rig mobilization & installation	1&2
	Rig installation	2
	Drilling operations	2 – 23
Production/Operations		5 – 23
Decommissioning		24 & 25

[1] All project phases will have varying amounts of ice roads/trails/pads, vessel traffic, and aircraft traffic. These are outlined in the following sections.
[2] Hilcorp has indicated a goal to complete all LDPI construction in the first year the regulations would be valid; however, they may need to install foundation piles in year 2.

2.1.1.1 Activities Occurring Throughout the Duration of the Project

All four phases of the Liberty Project will include varying amounts of ice road, ice trail, and ice pad construction as well as vessel and aircraft traffic. Best Management Practices limit on-ice activities in undisturbed areas after March 1st. If construction of ice roads, ice trails, or ice pads are necessary after March 1st, additional BMPs will be implemented, and consultation with NMFS is required to help avoid possible destruction of ringed seal lairs (see Section 2.1.2).

Ice Roads

Hilcorp proposes to construct three ice roads over sea ice and a fourth ice road over tundra (Figure 2) at varying times throughout the life of the project (Table 2):

- Ice road # 1 will extend approximately 11.3 km (7 mi) over shorefast sea ice from the Endicott SDI to the LDPI (the SDI to LDPI ice road). It will be approximately 37 m wide (120 ft) with driving lane of approximately 12 m (40 ft).

- Ice road # 2 (approximately 11.3 km [7 mi]) will connect the LDPI to the proposed Kadleroshilik River gravel mine site and then will continue to the juncture with the Badami ice road (which is ice road # 4). It will be approximately 15 m (50 ft) wide.

- Ice road # 3 (approximately 9.6 km [6 mi], termed the “Midpoint Access Road”) will intersect the SDI to LDPI ice road and the ice road between the LDPI and the mine site. It will be approximately 12 m (40 ft) wide

- Ice road # 4 (approximately 19.3 km [12 mi]), located completely onshore, will parallel the Badami pipeline and connect the gravel mine site with the Endicott road (Figure 2).

Table 2. Timing of Liberty Project ice road construction.

Ice Road	Location	Years Ice Roads will be Constructed	Seasonal Timing
1	Endicott to LDPI	1–25	December – May[1]
2	LDPI to Mine Site	1-3 & 24-25	
3	Midpoint Access Road	1-3	
4	Badami (onshore)[2]	1-3 & 24-25	

[1]Construction will be initiated prior to March 1st. Areas that have not been disturbed by construction work prior to March 1st will not be disturbed after March 1st without consultation with NMFS, and the implementation of additional mitigation measures.
[2]This ice road is generally built annually for access to Badami and/or Pt. Thompson.

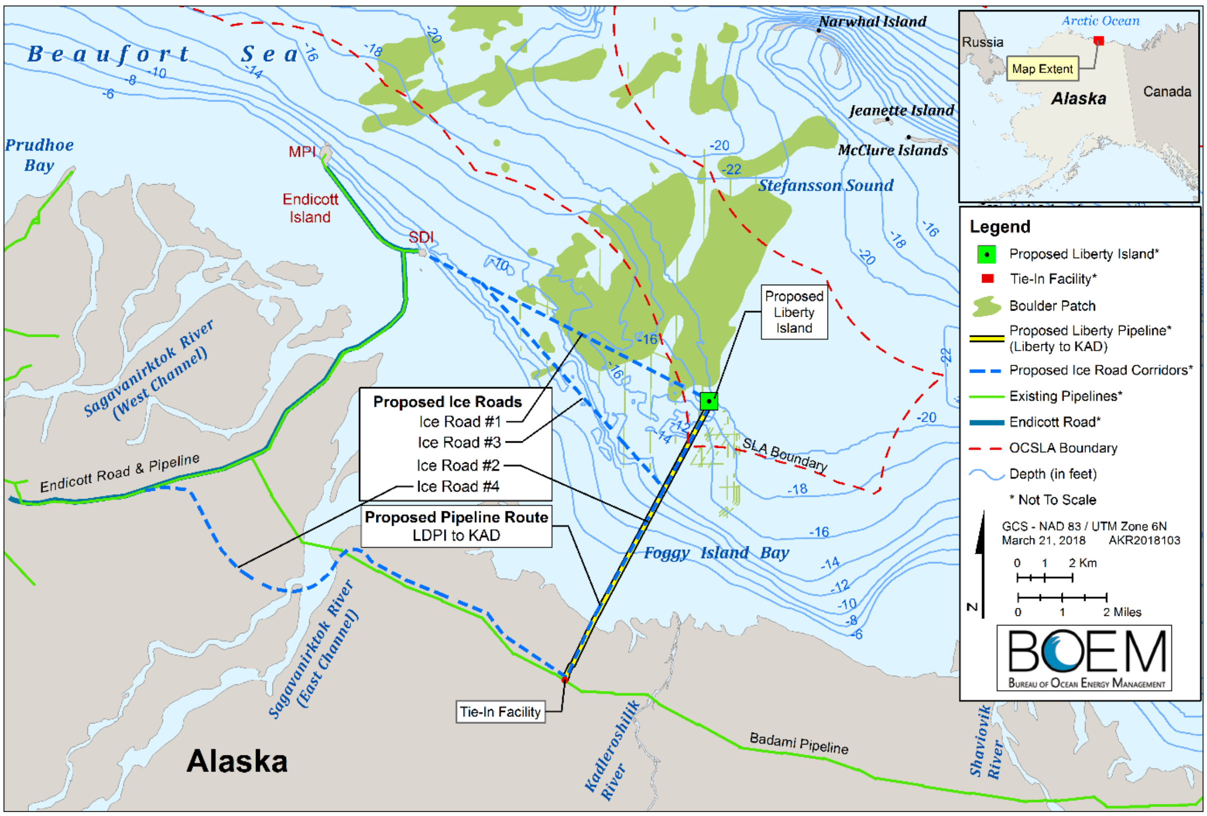


Figure 2. Liberty Project ice road routes (BOEM 2017a).

Ice road #1 (annual ice road between the Endicott SDI and LDPI) will be approximately 37 m (120 ft) wide and have a driving lane width of 12 m (40 ft). This road will be constructed to allow materials and equipment to be mobilized to support construction of the LDPI and pipeline, support production operations for LDPI including resupply and personnel transport, and support decommissioning activities. It will cover approximately 160 ac (65 ha) of sea ice in total.

Ice roads #2, #3 and #4 will be 12 to 15 m (40 to 50 ft) wide. These roads will allow transportation between existing North Slope roads, the gravel mine site (located onshore 7 mi south of the LDPI), and the LDPI. They will also support pipeline installation, including the offshore section, the onshore portion, and the tie-in to the Badami pipeline.

The timing of ice road construction will vary each year depending on the required width and thickness of the ice road and whether the road is onshore or offshore. Ice road construction can typically be initiated in mid to late December and completed prior to March 1. Ice roads can be maintained until end of May in the following year. Hilcorp plans to initiate construction of all ice roads prior to March 1. Ice roads are best constructed when weather is -20 to -30 degrees Fahrenheit (ºF), but temperatures below 0ºF are considered adequate for ice road construction. When use of an ice road has ended, the ice road will be barricaded by a snow berm to prevent use of the road and allowed to melt naturally in spring.

The following equipment will be used to construct ice roads: graders, water pump units equipped with ice augers, and construction vehicles. Based on a sound source verification study conducted at Northstar (Greene et al. 2008) and modeling conducted by SLR Consulting, it is anticipated that ice road construction activities will result in an average sound pressure level of 189.1 dB re 1µPa (SLR Consulting 2017).

In preparation for building the ice road, snow will be cleared away from the route and ice rubble will be smoothed into the ice surface or moved outside of the expected road surface. The ice roads will then be constructed by pumper units equipped with ice augers that will drill holes in the sea ice and pump water from under the ice to flood the surface of the ice. The ice augers and pumping units will continue to move along the ice road alignment to flood the entire alignment, returning to a previous area as soon as the flooded water has frozen. Flooding techniques are dependent on the conditions of the sea ice. Grounded ice typically requires limited flooding with fresh water to either cap or repair cracks. Floating ice requires flooding with seawater until a desired thickness is achieved. Thickness of floating ice will be determined by the required strength and integrity of the ice. After the desired thickness is achieved, floating ice may then be flooded with fresh water to either cap or repair cracks. This technique minimizes the usage of fresh water while obtaining the desired thickness of the ice road. Ice roads will be maintained and kept clean of gravel and other solids.

Cracks in the ice road can form due to heavy use or ice movement caused by weather events. Cracks can also be caused by ice movement in the transition zone of nearshore bottom-fast ice and floating ice. Cracks reduce the bearing capacity of the ice cover. Methods used to bridge ice cracks and natural leads (see Figure 3) will use established ice road best management practices and procedures (see Section 2.1.2). Cracks generally repaired by filling them with water and allowing them time to freeze fully. This also includes bridging the crack by strengthening the ice with a thickened layer of ice and sometimes reinforcing the thickened ice with metal grates (rigs mats) or similar support material (BOEM 2018b).

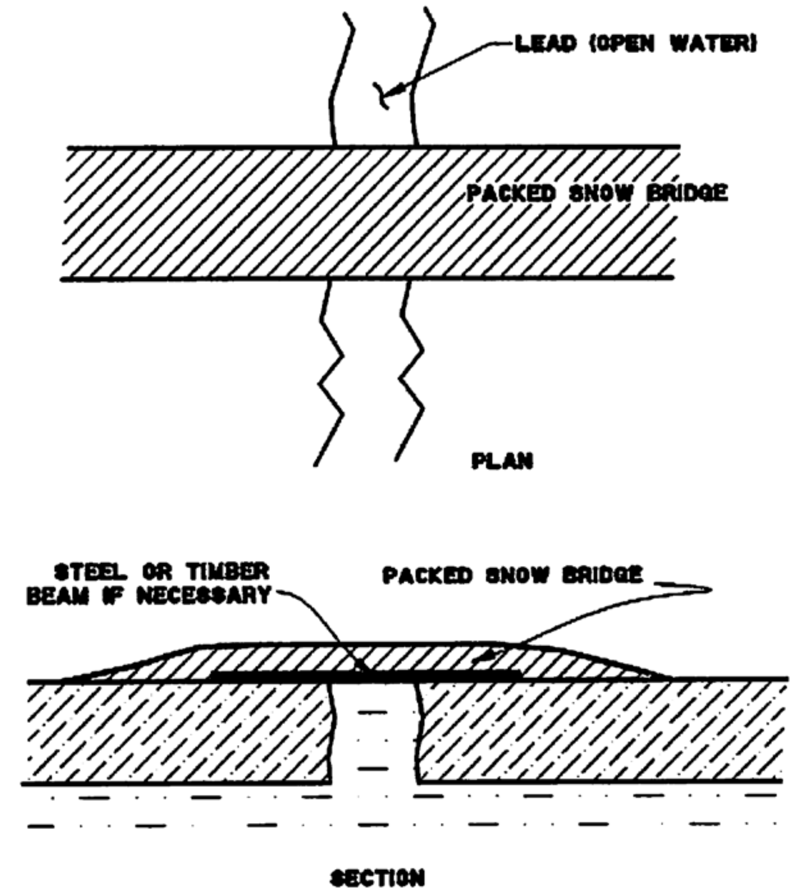


Figure 3. Example of how a steel plate or wooden rig mat would be used to bridge a lead. Plate or rig mat would be placed over the lead, and then snow packed on top to freeze it into place and form a bridge across the opening in the ice (BOEM 2018b).

Routine maintenance (i.e., blowing, blading, and flooding) of damaged areas on an ice road is an important control measure in maintaining safe ice cover throughout the season. When blowing snow off the road bed, some snow may be deposited beyond the disturbed ice road “shoulder” but this would be windblown, and not involve mechanical footprint off the disturbed road corridor (BOEM 2018b).

The Alaska Department of Natural Resources (ADNR) regulates many aspects of winter travel on Alaska’s North Slope. ADNR’s Division of Mining, Land, and Water (DMLW) is responsible for permitting ice road construction and winter travel without ice roads while the Water Resources Office regulates temporary water withdrawal (used for onshore ice road construction) from rehabilitated and existing mine sites and tundra ponds. Hilcorp currently holds a general permit (# LAS 29963) for ice road and ice pad construction using State approved vehicles on all State owned lands on the North Slope bordered by the Canning River to the east, the Colville River to the west, and the Brooks Range to the south. This permit requires an annual application showing the location, an anticipated schedule of operations, and a list of vehicles/equipment used for travel, among several other items.

It is assumed that ice roads and ice pads will be constructed under this, or a similar permit, regulated by ADNR. Further, all manipulation of snow and ice along the Right of Ways (ROW) will be in relation to ice roads and will be kept within the confines of the ice road ROW.

Ice Trails

An ice trail is a travel corridor used for offshore site access, similar to an ice road. It is constructed by plowing the snow off the ice and capping the sea ice with an additional thin layer of ice. An ice trail is not built to the specifications of an ice road for wheeled vehicles. It will be maintained so as to be easily travelled by a tracked vehicle (Tucker) and to not accumulate a thick layer of snow. The ice trail is used when operations do not require heavy vehicles, and will be used primarily for personnel transport. If an ice trail is developed and used during the life of the project, it will most likely follow the route of Ice Road #1, extending approximately 11.3 km (7 mi) over shorefast sea ice from the Endicott SDI to the LDPI (the SDI to the LDPI ice road).

Maintenance of ice trails will occur as required, approximately once every two weeks. This would consist of driving the route with a tracked vehicle thereby compacting the route as well as monitoring the route delineation.

There would be no other designated on-ice activities associated with the project as ice roads and ice trails will be used for transport. If additional on-ice activities become necessary in the future, Hilcorp will conduct additional discussions with NMFS and BOEM (BOEM 2018b) to determine if these activities modify the action in a manner that causes an effect not previously considered.

Ice Pads

In years 2 and 3, three ice pads (1 onshore and 2 offshore) and a storage area will support island, pipeline, and facilities construction, including the pipe stringing and two stockpile/disposal areas needed for pipeline construction. One offshore ice pad will run along the pipeline route and ice road #2 to support pipeline installation (see zone 1 in Figure 4). The ice pad will be approximately 61 m (200 ft) wide and will only run along a portion of ice road # 2; however, for the purposes of this opinion, NMFS will evaluate the ice pad extending the entire length of the pipeline corridor on both floating and bottom-fast ice. The second offshore ice pad will be located on nearshore bottom-fast ice along the pipeline route and ice road #2 (see zone 2 in Figure 4). This ice pad will be approximately 1,524 m by 610 m (5,000 ft by 2,000 ft). The third ice pad will be located onshore. During well drilling operations, an additional storage area of approximately 107 m by 217 m (350 ft by 700 ft) will be built on the sea ice on the west side of the island. This site will be used to store tubulars and other clean materials.

Construction of ice pads, including methods and equipment, will be the same as for the construction of ice roads. Similar to ice roads, ice pads will be used between December and May.

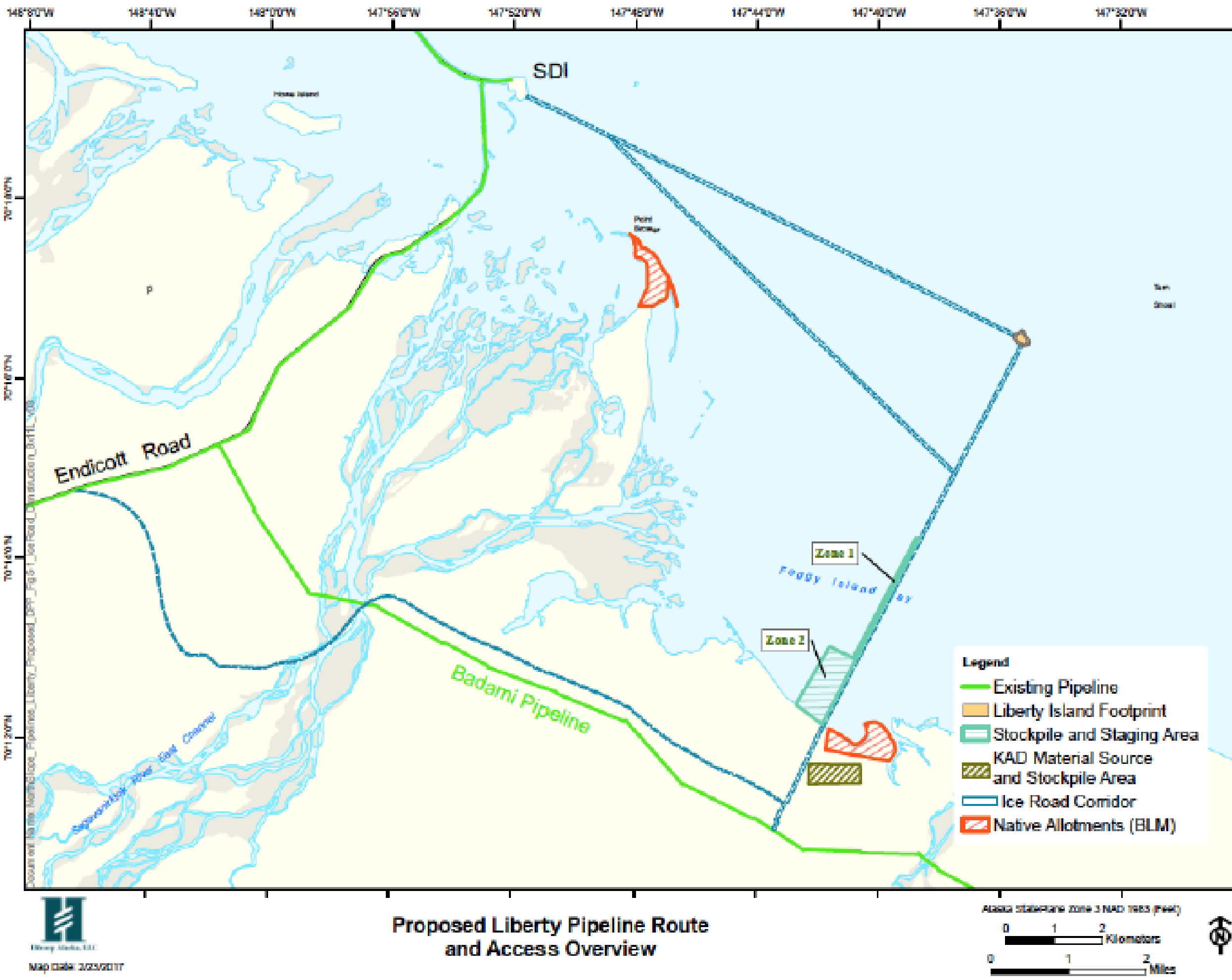


Figure 4. Liberty Project ice pad locations (Hilcorp 2017).

Marine Transportation

Throughout the life of the project, during the open-water season, barges, hovercraft, and other vessels will be used to transport equipment, personnel, and supplies to LDPI. The open-water season is typically July through October; however, because the timing of the open-water season varies from year to year, this opinion evaluates marine transportation based on a conservative time frame of June through November. Coastal barges, hovercraft, and small vessels will travel from West Dock or Endicott SDI to the LDPI (Figure 5). The marine transit route from West Dock to the LDPI is about 40 km (25 mi) and from Endicott SDI to the LDPI, the route is about 12.4 km (7.7 mi). Large sea-going barges will travel approximately 3,000 km (1,864 mi) from Dutch Harbor to West Dock or Endicott SDI (Figure 6). Amphibious vehicles may also be used for emergency evacuation. Annual inspection surveys for the life of the project will require the use of a bathymetry vessel. This vessel will be used in the immediate surrounding waters of the island and along the pipeline corridor.

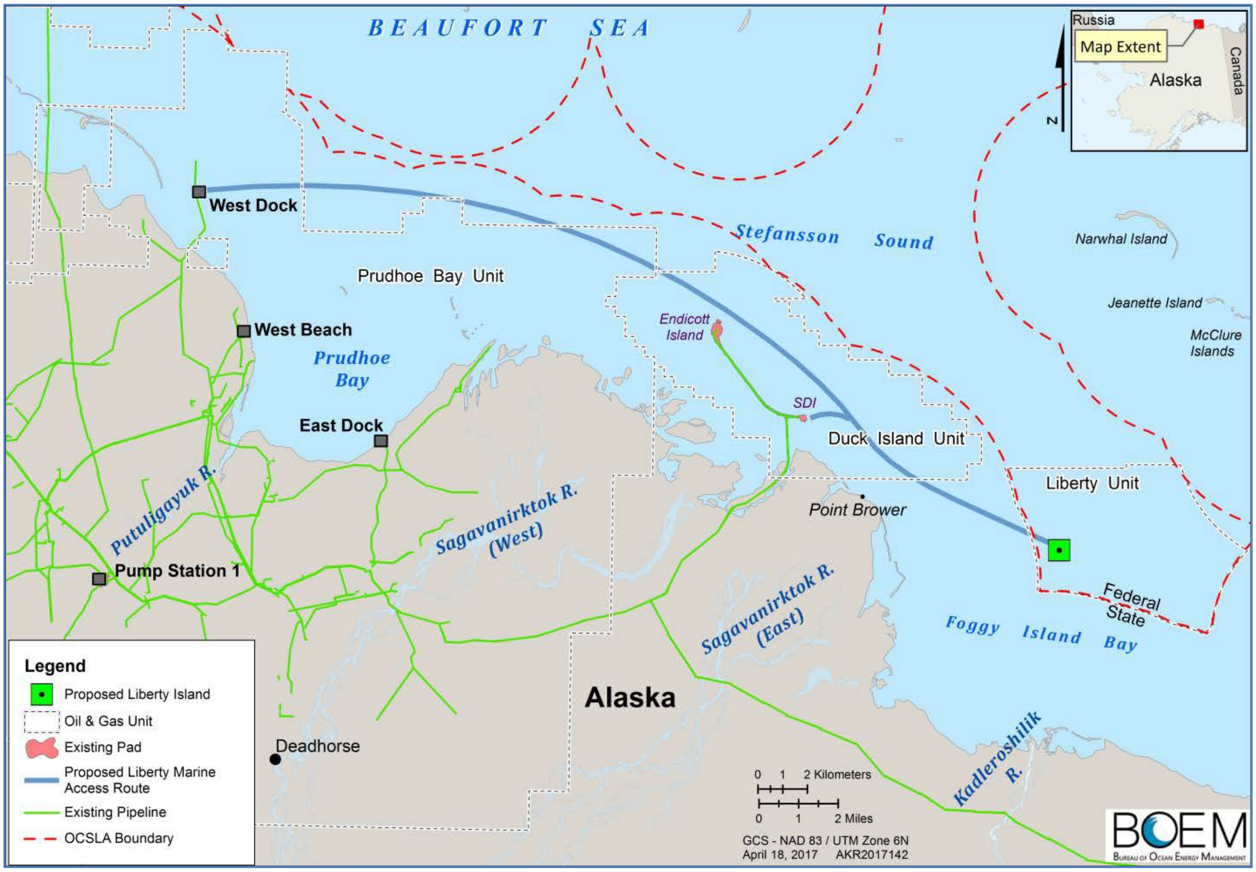


Figure 5. Marine transit route from West Dock and Endicott SDI to LDPI (BOEM 2017a).

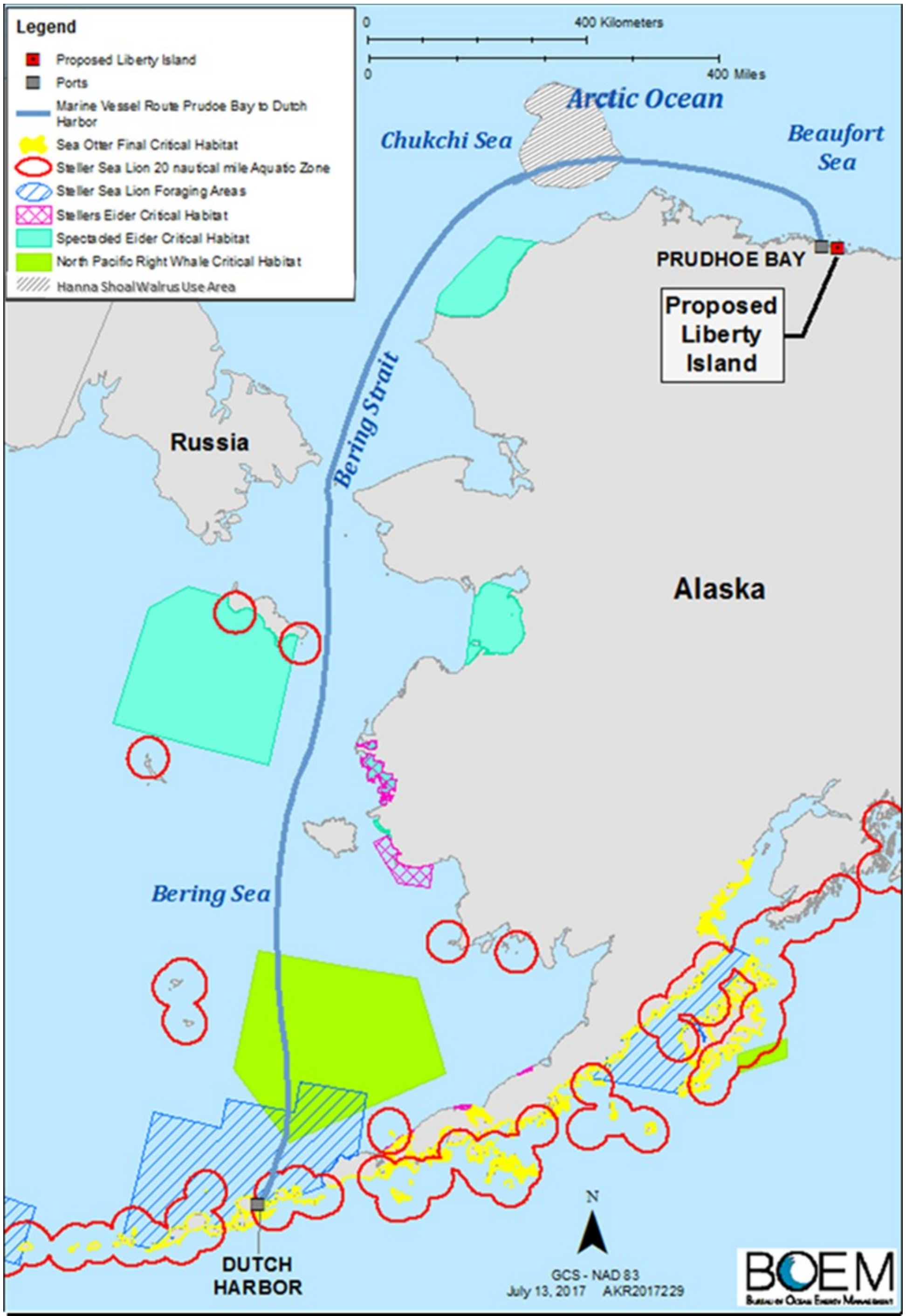


Figure 6. Marine transit route from Dutch Harbor to LDPI (BOEM 2017a).

Table 3 summarizes the number and types of vessels that will be used during the life of the project and the maximum number of trips expected per year by vessel type. As mentioned above, this opinion takes a conservative approach in evaluating the open-water season from June through November (180 days). The open-water season is likely to be shorter in any given year; therefore, the maximum numbers of trips outlined in Table 3 are considered overestimates.

Table 3. Summary of Liberty Project marine transportation.

Vessel Type[1]	**Number of Vessels**	**Number of Trips Per Vessel**[2]					
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Years 5-23**	**Years 24-25**
Sea going barges & tugs (*barge is ~ 100 ft wide and 400 ft long; tug is ~ 100 ft long*)	2 of each	5/year	5/year	6/year	7/year	1 per 5 years	5/year
Coastal barges & tugs *(barge <200 ft long; tug <80 ft long)*	2 of each	Up to 540/year	Up to 540/year	Up to 560/year	Up to 570/year	Up to 10/year	Up to 570/year
Crew boat *(~ 43 ft long)*	2	Up to 2,160/year	Up to 2,160/year	Up to 2,520/year	Up to 2,610/year	Up to 90/year	Up to 2,610/year
Hovercraft *(Griffin 2000 TD, <30 ft long)*	1	Up to 3/day	Up to 3/day	Up to 5/day	Up to 7/day	Up to 2/day	Up to 2/day
Bathymetry vessel *(40 ft long by 14 ft wide)*	1	1 survey per year lasting up to 7 days					
Amphibious vehicles	2	As needed (used in emergency evacuations)					

[1] Sea going barges and tugs will utilize the marine transit route to and from Dutch Harbor and LDPI, while the remaining vessel types will be used for transportation among locations within Stefansson Sound.
[2] Maximum numbers of trips per year are considered overestimates in that the open-water season in a given year is likely to be less than the 180-days from June to November time frame assumed in the analysis.

The primary underwater noise associated with barging 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 source (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. 1995c, Simmonds et al. 2004). Coastal barges and tugs produce a peak sound source level of approximately 164 dB re 1 μPa_{rms} at 1 m (Richardson et al. 1995c). 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. 1995c) and 149 dB re 1 μPa_{rms} at 1 m (Blackwell and Greene 2005), respectively. For the marine transit route, 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. 1995c).

Ground Transportation

Hilcorp does not anticipate ground vehicle (heavy duty diesel trucks, light duty diesel pickup trucks, trimmers, tractors, loaders, and excavators, etc.) transit on ice without the use of ice roads.

The largest volume of traffic on ice roads is anticipated to occur in years 1 through 3 of island, pipeline, and facility construction, with approximately 21,000 to 21,400 trips per winter season. The highest volume of traffic will occur during gravel hauls to construct the LDPI (year 2). Hilcorp anticipates that gravel hauling will require approximately 14 trucks working 50 to 70 days. Ground transportation on ice is expected to decrease to less than 500 trips per year for the remainder of the project during drilling, production operations, and decommissioning.

Based on the Greene et al. (2008) sound source verification study conducted at Northstar, it is anticipated that trucks transiting on ice roads will result in an average underwater sound pressure level of 179.1 dB re 1µPa at 1 m and in-air sound source level of 74.8 dB re 20µPa at 100 m (SLR Consulting 2017).

Air Transportation

Helicopter

Hilcorp plans to access the LDPI year-round via helicopter when weather and visibility permit. A helicopter landing site will be constructed on LDPI near the living quarters. In general, helicopters will be used for transport of personnel and supplies and equipment when necessary (e.g., resupply during the broken ice seasons). Helicopter use is also planned for maintenance and inspection of the onshore pipeline system. Typically, air traffic routing will be as direct as possible from the departure locations (e.g., SDI, West Dock, or Deadhorse to the LDPI), with routes and altitude adjusted to accommodate weather, other air traffic, and to avoid disrupting subsistence activities.

Table 4 outlines the anticipated number of helicopter trips per day in a given year during the life of the project. Helicopters may be utilized year-round and up to 365 days per year. However, considering helicopter traffic is dependent on weather conditions and project needs, it is unlikely that the maximum number of trips per day will be utilized every day in a given year. In the period between completion of hydro-testing and facilities start-up (predicted to occur in year 3), an estimated one or two helicopter flights per week will be required for several weeks for personnel access and to transport equipment to the tie-in area.

Table 4. Liberty Project helicopter trips per day.

Project Phase	Number of Trips per Day	Maximum Number of Round Trips per day					
		Year 1	Year 2	Year 3	Year 4	Year 5 - 23	Years 24 - 25
Construction	1 or 2	2	2	2	2	0	0
Drilling	2	0	0	2	2	0	0

Project Phase	Number of Trips per Day	Maximum Number of Round Trips per day					
		Year 1	Year 2	Year 3	Year 4	Year 5 - 23	Years 24 - 25
Production	2	0	0	2	2	2	0
Decommissioning	1 or 2	0	0	0	0	0	2
Total round trips per day		2	2	4	6	2	2

Except during takeoff and landing, helicopters will fly at an altitude of 457 m (1,500 ft). The underwater noise generated by helicopters flying at altitudes of 150 m (500 ft) or more are expected to be around 109 dB re 1µPa (Richardson et al. 1995c). In-air sound pressure levels of a helicopter flying at an altitude of 300 m (984 ft), similar to takeoff and landing altitudes, have been measured to be 84 dB re 20µPa at 300 m (Boeker and Schulz 2010, SLR Consulting 2017).

Fixed-wing Aircraft

Fixed-wing aircraft may be used for pipeline monitoring, marine mammal monitoring, or in the event of an oil spill. Fixed-wing aircraft will not be regularly used for the project and are assumed to be used for up to two fixed-wing over flights per year, originating from Prudhoe Bay Airport. Typical fixed-wing aircraft used for monitoring will include a DHC-6 Twin Otter with a fuel capacity of 1,514 liters (400 gal). Greene and Moore (1995) determined that fixed-wing aircraft typically used in offshore activities were capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 162 dB re 1 µPa m at the source.

Similar to helicopters, except during takeoff and landing and in emergency situations, aircraft will maintain an altitude of at least 457 m (1,500 ft). If a marine mammal is observed, then a horizontal distance of 305 m (100 ft) of whales or seals will be maintained between the aircraft and the observed marine mammals (see Section 2.1.2).

Unmanned Aircraft System

Hilcorp may use Unmanned Aircraft Systems (UASs) during construction, and subsequently during decommissioning to monitor for marine mammals in the Level B harassment zones created by pile driving, pipe driving, and slope shaping and armament activities during the open-water season. Recent developments in the technical capacity and civilian use of UAS (defined as vehicles flying without a human pilot on board) have led to some investigations into the potential use of these systems for monitoring and conducting aerial surveys of marine mammals (Koski et al. 2009, Hodgson et al. 2013, Duke 2015). UASs, operating under autopilot and mounted with GPS and imaging systems, have been used and evaluated in the Arctic (Koski et al. 2009) and have the potential to replace traditional manned aerial surveys and provide an improved method for monitoring marine mammal populations.

Hodgson et al. (2013) conducted marine mammal surveys using a ScanEagle UAS flown at 152 m (500 ft). The survey consisted of 10 transects spaced at 72 m (235 ft) intervals (the width of view of the water surface within the images). The width of view at each altitude was the effective transect strip width. The image capture rate was set to achieve 10 percent overlap in images. The overlap in images was useful in detecting animals masked by reflection on the sea surface or animals at awkward body angles.

A similar approach is being considered for Liberty but specific details will be determined based on the specifications of the UAS to be used and through discussions with NMFS. The UAS that may be used by Hilcorp will be a fixed-wing aircraft, mounted with a live-stream digital single-lens reflex camera, for monitoring marine mammals.

The UAS will fly at an altitude of 152 m (500 ft; or other altitude determined appropriate based on the platform) and a transect width to be determined through discussions with NMFS.

The UAS will maintain a minimum altitude of 152 m (500 ft), unless a higher minimum altitude is necessary to minimize disturbance to marine mammals.

Transects will likely be divided into sections that are 30 minutes of longitude across, as done by the Aerial Survey of Arctic Marine Mammals (ASAMM). End points for the survey transects may be selected at random but will specifically cover the survey area and allow for a continuous flight path within the survey area. If small boats are observed, the UAS pilot will truncate the transect to avoid interference with subsistence activities. The UAS will not be used to circle marine mammals. If it is too windy, or other weather condition prevent use of a UAS, activities will be adjusted accordingly and a backup plan of using a Protected Species Observer (PSO) based on land or, if necessary on a vessel, will be implemented.

If necessary, Hilcorp will seek a waiver from the Federal Aviation Administration (FAA) to operate the UAS above 400 ft and beyond the line of sight of the pilot. Ground control for the UAS will be located at Liberty Island, Endicott, or another shore-based facility close to Liberty.

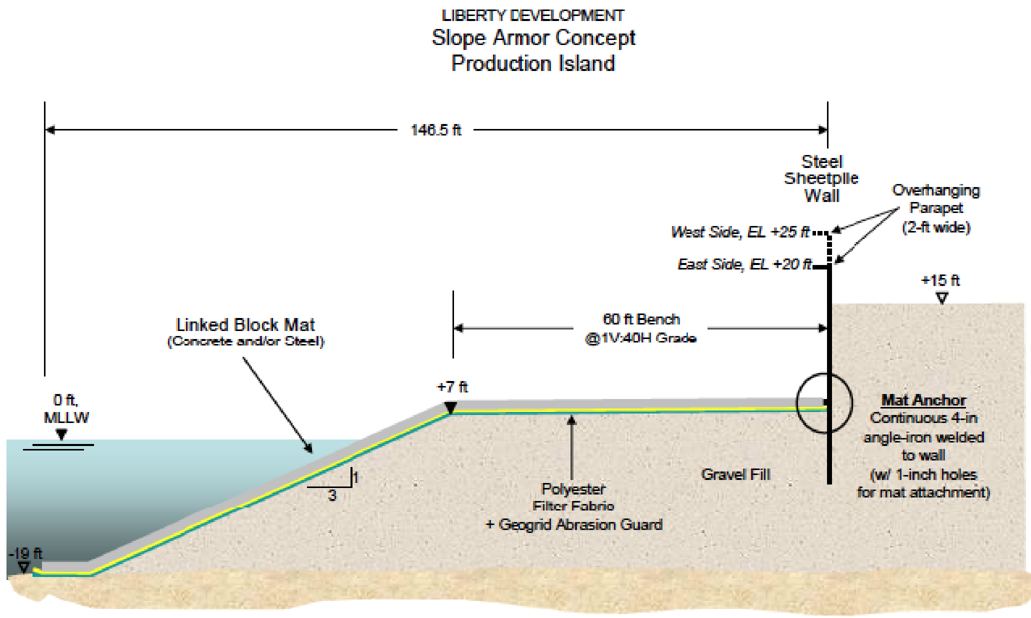
2.1.1.2 Island Construction

The LDPI will be an artificial island constructed in 5.8 m (19 ft) of water in Foggy Island Bay of the Beaufort Sea, approximately 8 km (5 mi) north of the Kadleroshilik River and 11.7 km (7.3 mi) southeast of the existing SDI on the Endicott causeway. Construction of the artificial island will involve strategic placement of approximately 929,900 cubic yards (cy) of gravel, secured with sheet piling, and armored with linked concrete mats (Figure 7). The island is designed to have a working surface of approximately 3.8 ha (9.3 ac) and a seabed footprint of approximately 9.7 ha (24 ac). The island will be constructed of gravel from the proposed mine site west of the Kadleroshilik River.

Island slope protection is required to ensure the integrity of the gravel island by protecting it from the erosive forces of waves, ice ride-up, and currents. As shown in Figure 8, the island will have a working surface elevation of 4.6 m (15 ft) above mean lower low water (MLLW), with a sheet pile wall rising to 6.1 to7.6 m (20 to 25 ft) above MLLW depending on the side of the island. The slope protection profile includes a 60-ft wide bench covered with a linked concrete mat that extends from the sheet pile wall to slightly above MLLW; the concrete mat continues to 5.8 m (19 ft) below sea level. The elevation of the outer edge of the bench subgrade will be 2.1 m (7 ft) above MLLW. The bench will dissipate wave and ice forces and will provide operational support for equipment and personnel around the island for construction, maintenance, spill response, and major incident evacuation. The horizontal distance from the sheet pile wall to the toe of the slope armor measures approximately 46 m (150 ft). These dimensions were used to calculate the seabed footprint of the island.

The island will be overbuilt by a height of 0.9 m (3 ft) on the working surface and by 0.6 m (2 ft) on the bench surface. This overbuild will compensate for settling and thaw subsidence.

Figure 7. 3-D rendering of completed LDPI (BOEM 2017a).



Note: concrete block pad footings are placed on top of the gravel. They are not part of the mat anchoring system.

Figure 8. LDPI artificial island profile (Hilcorp 2017).

Gravel Placement

Island construction will commence once the ice road from the proposed gravel mine site to the LDPI construction site is completed. During the process of construction during the winter to mid-April of year 1, sections of sea ice will be cut and removed from the location of the island and placed in shallow waters less than 3 m (10 ft). A Ditchwitch will be used to cut through the ice while a backhoe and support trucks will move the ice away.

Once the ice is removed, gravel will be poured through the water column to the sea floor, building the island structure from the bottom up. A conical pile of gravel will form on the sea floor until it reaches the surface of the ice. The construction will continue with a sequence of removing additional ice and pouring gravel until the surface size is achieved.

Gravel will be retrieved from the onshore gravel mine site and will be transported by ice road to the LDPI. Transport of gravel from the mine site to the LDPI will require approximately 14 all-terrain vehicles working 50 to 70 days, plus additional surface vehicles, such as skimmers, tractors, loaders, and excavators.

Based on the Greene et al. (2008) sound source verification study conducted at Northstar and modeling conducted by SLR Consulting, it is anticipated that Ditchwitch activities and trucks transiting on ice roads during ice-covered conditions will result in average underwater sound pressure levels of 169.6 and 179.1 dB re 1µPa at 1 m, respectively, and in-air sound source levels of 76.3 dB re 20µPa at 100 m and 74.8 dB re 20µPa at 100 m, respectively (SLR Consulting 2017).

Slope Shaping and Armament Installation

Using island-based equipment (e.g., backhoe, bucket-dredge) and divers, Hilcorp would create a slope protection profile consisting of a 60-ft (18.3 m) wide bench covered with a linked concrete mat that extends from a sheet pile wall surrounding the island to slightly above mean low low water (MLLW). Slope shaping and armament installation will follow placement of the gravel and could occur from January through September. However, slope shaping and armament installation will take a total of approximately 14 days and 9.6 hours per day and will not occur daily. An excavator will be used to grade and smooth the gravel fill. Once smoothed, approximately 39,948 square meters (430,000 square feet) of linked concrete mat will be installed over the gravel to protect and stabilize the gravel island. The linked concrete mat requires a high strength, yet highly permeable woven polyester fabric under layer to contain the gravel island fill. The filter fabric panels will be overlapped and tied together side-by-side (requiring diving operations) to prevent the panels from separating and exposing the underlying gravel fill. Because fabric is overlapped and tied together, no slope protection debris would enter the water column should it be damaged. Above the fabric under layer, a robust geo-grid will be placed as an abrasion guard to prevent damage to the fabric by the linked mat armor. To minimize erosion and turbidity, a temporary slope protection, consisting of 4-cy gravel bags and 10-ft-square gravel-filled mattresses, may be used at times. Based on the Greene et al. (2008) sound source verification study conducted at Northstar and modeling conducted by SLR Consulting, it is anticipated that the use of an excavator or backhoe will result in an average underwater sound pressure level of 177.7 dB re 1µPa at 1 m during ice-covered conditions (SLR Consulting 2017). During open water conditions underwater sound pressure levels are anticipated to be 167 dB re $1\mu Pa_{rms}$ at 1 m (Richardson et al. 1995c, SLR Consulting 2017). In-air sound source level of 78 dB re 20µPa at 10 m (DEFRA 2006, SLR Consulting 2017).

A detailed inspection of the island slope protection system will be conducted annually during the open-water season to document changes in the condition of the island slope protection system that have occurred since the previous year's inspection. Any damaged material would be removed. Above-water activities will consist of a visual inspection of the dock and sheet pile enclosure, and documenting the condition of the island bench and ramps. The below-water slopes will be inspected by divers or if water clarity allows, remotely by underwater cameras contracted separately by Hilcorp. The results of the below water inspection will be recorded for repair if needed. No vessels will be required. Multi-beam bathymetry and side-scan sonar imagery of the below-water slopes and adjacent sea bottom will be acquired using a bathymetry vessel. The sidescan sonar would operate at a frequency between 200-400 kilohertz (kHz). The single-beam echosounder would operate at a frequency of about 210 kHz.

The LDPI slopes could require ongoing maintenance for protection from erosion due to winds and waves. Comparatively, on Northstar Island which is outside the protection of the barrier islands, Hilcorp replaces about 25 of 18,000 (0.0014 percent) concrete mats annually, and about 200 of 18,000 (0.011 percent) concrete mats every 5 years on a routine island repair cycle. During operation of the LDPI, all damaged mats will be retrieved and replaced as needed, and damaged mats will not be lost into the ocean.

Sheet Pile Driving

In addition to the concrete mats, 823 m (2,700 feet) of Z sheet piles will be installed around the perimeter of the island to protect the gravel island from erosion. This sheet pile wall will be installed at the back of the 18-m (60-ft) wide bench (Figure 8) to a depth of 8 m (25 ft). The wall protects the work surface of the island from ice and wave impacts. This design is similar to that of Northstar Island, which was constructed by BPXA in 2000. Given the high storm surge and larger waves that are expected to arrive at the LDPI site from the west and northwest, the wall will be higher on the west side than on the east side. This differing wall height was also successfully implemented at Northstar. Engineering work will be conducted in the final engineering phase to confirm the exact height and construction techniques for the sheet pile wall. At this time, the wall elevation on the east side is assumed to be 6.1 m (20 ft) above MLLW, and the elevation on the west side is assumed to be 25 ft above MLLW (Figure 8). At the top of the sheet-pile wall, overhanging steel "parapet" will be installed to prevent wave passage over the wall.

The sheet pile wall is expected to be driven in year 1, however, if island construction takes two winter construction seasons, sheet pile driving may also occur in year 2. Sheet pile driving is anticipated to be conducted between March and August, during approximately 4 months of the ice covered season and 15 days of the open-water season. Hilcorp plans to conduct sheet pile driving during the open-water season from July 1 through July 15; however, to be conservative and to accommodate for project delays, this opinion evaluates pile driving for 15 non-consecutive days up until August1, the anticipated date the bowhead whale hunt starts, during which pile driving is not authorized.

Sheet pile driving methods and techniques are expected to be similar to the installation of sheet piles at Northstar. A vibratory hammer will initially be used to drive sheet pilings (Shepard et al. 2001). A vibratory hammer is a heavy device attached to a standing sheet pile which vibrates vertically, driving the sheet into the ground. For vibratory driving, pile penetration speed can vary depending on ground conditions, but a minimum sheet pile penetration speed is 20 inches (0.5 m) per minute to avoid damage to pile or hammer (NASSPA 2005). For this project, the anticipated duration is based on a preferred penetration speed greater than 40 inches (1 m) per minute, resulting in 7.5 minutes to drive each pile. It is expected that one sheet pile will take 7.5 minutes to install and up to 20 sheet piles will be installed in a day, resulting in approximately 2.5 hours of cumulative sheet pile driving per day. The specific model of the vibratory hammer that will be used is unknown; however, it is expected that the vibratory hammer will be similar to the one used at Northstar. Based on the Greene et al. (2008) sound source verification study conducted at Northstar, Caltrans (2007), and modeling conducted by SLR Consulting, the vibratory hammer is anticipated to result in an average underwater sound pressure level of 221 dB re 1µPa at 1 m during ice covered conditions and 202 dB re 1µPa at 1 m during the open-water season (SLR Consulting 2017). The in-air sound source level is anticipated to be 81 dB re 20µPa at 100 m (Greene et al. 2008, SLR Consulting 2017).

After sheet pilings are installed to a certain depth using vibration, impact pile driving will be used to further set the piles deeper into the substrate. Hilcorp plans to use a Delmag D62-22 impact hammer, or similar, with a strike rate of 35 to 50 strikes per minute. It will take approximately 2 minutes (100 strikes) to finish installing one pile. To finish installing up to 20 piles per day, the impact hammer will be used a maximum of 40 minutes (2,000 strikes) per day with an anticipated duration of 20 minutes per day.

Based on the findings of Greene et al. (2008), Caltrans (2007), and modeling conducted by SLR Consulting, it is anticipated that the use of an impact hammer on installation of sheet piles will result in an average underwater sound pressure level of 235.7 dB re 1µPa at 1 m during ice covered conditions and 225 dB re 1µPa at 1 m during the open-water season (SLR Consulting 2017). The in-air sound source level is anticipated to be 93 dB re 20µPa at 160 m (Blackwell et al. 2004a, SLR Consulting 2017).

Pipe Driving

The LDPI will have 16 wells located in the interior of the island. Each well will have a 20 in (51-cm) conductor pipe driven to a depth of 49 m (160 ft). Conductor pipes will also be driven using the Delmag D62-22 impact hammer, or similar, with a strike rate of 35 to 50 strikes per minute. However, depending on the substrate, the conductor pipes could be driven by vibratory driving or drilling (auger). Blackwell et al. (2004a) observed impact pipe driving at Northstar. On most days, one conductor was driven in a day over a period of 5 to 8.5 non-consecutive hours. The longest day of observation was 10.5 non-consecutive hours in which time two pipes were driven. Based on the 20 percent impact hammer usage factor (USDOT 2006.), it is expected that 2 cumulative hours of impact pipe driving (4,400 to 3,600 strikes) will occur over a 10.5 non-consecutive hour day.

The conductor pipes are expected to be driven in year 1; however, if island construction takes two winter construction seasons, conductor pipe driving may also occur in year 2. Conductor pipe driving is anticipated to be conducted between March and August and take 16 days total, installing one pipe per day.

Based on modeling conducted by SLR consulting and results from Northstar construction presented in Blackwell et al. (2004a), it is anticipated that the use of an impact hammer on 20-in conductor pipes will result in an average underwater sound pressure level of 171 dB re 1µPa at 1 m during ice-covered conditions and 200 dB re 1µPa at 1 m during the open-water season (SLR Consulting 2017). The in-air sound source level is anticipated to be 93 dB re 20µPa at 160 m (SLR Consulting 2017). If vibratory pipe driving or drilling methods are used, they are expected to generate less noise than impact driving.

2.1.1.3 Pipeline

Pipeline Installation

Pipeline construction is planned to follow LDPI construction during the winter months (January through May) of year 2. The pipeline will extend from the LDPI to an onshore tie-in with the Badami pipeline system, approximately 11.4 km (7.1 mi). The offshore and onshore pipeline segments are planned to be installed within the same time frame by two separate construction crews and equipment. Offshore construction will progress from shallower to deeper water. Construction will involve: mobilizing equipment, material, and crew members; constructing the supporting ice road (Section 2.1.1.1); cutting a slot through the ice and excavating a trench (including temporary storage of excess materials); welding the pipeline bundle components;

placing the pipeline bundle in the trench; and backfilling the trench.

The offshore section of the pipeline will be constructed during the winter within a proposed temporary construction right-of-way (200 feet wide onshore, 1,500 feet wide offshore). An ice road and/or thickened sea ice will be built within the construction right-of-way to support pipeline construction. Work will be done from thickened ice using conventional excavation and dirt-moving construction equipment (i.e., backhoe or excavator, Ditchwitch, and trucks). A Ditchwitch will be used to cut through the ice, then the pipeline trench will be excavated using long-reach excavators with pontoon tracks. The pipeline bundle will be lowered into the trench using side booms to control its vertical and horizontal position, and the trench will be backfilled by excavators using excavated trench spoils and select backfill. Hilcorp intends to place all excavated material back in the trench slot. Some gravel or gravel bags may be used as trench backfill near the transitions to shore and/or the LDPI. The offshore pipeline target trench depth will be 2.7 to 3.4 m (9 to 11 ft) with a maximum depth of cover of backfill of approximately 2.1 m (7 ft). The width of the trench will be approximately 2.1 m where the pipeline rests below the original seabed and up to 10-m (32-ft) wide at the seabed (Figure 9). The width of the ice being cut to install the pipeline will be slightly larger. The pipeline will be about 9 km (5.6 mi) long.

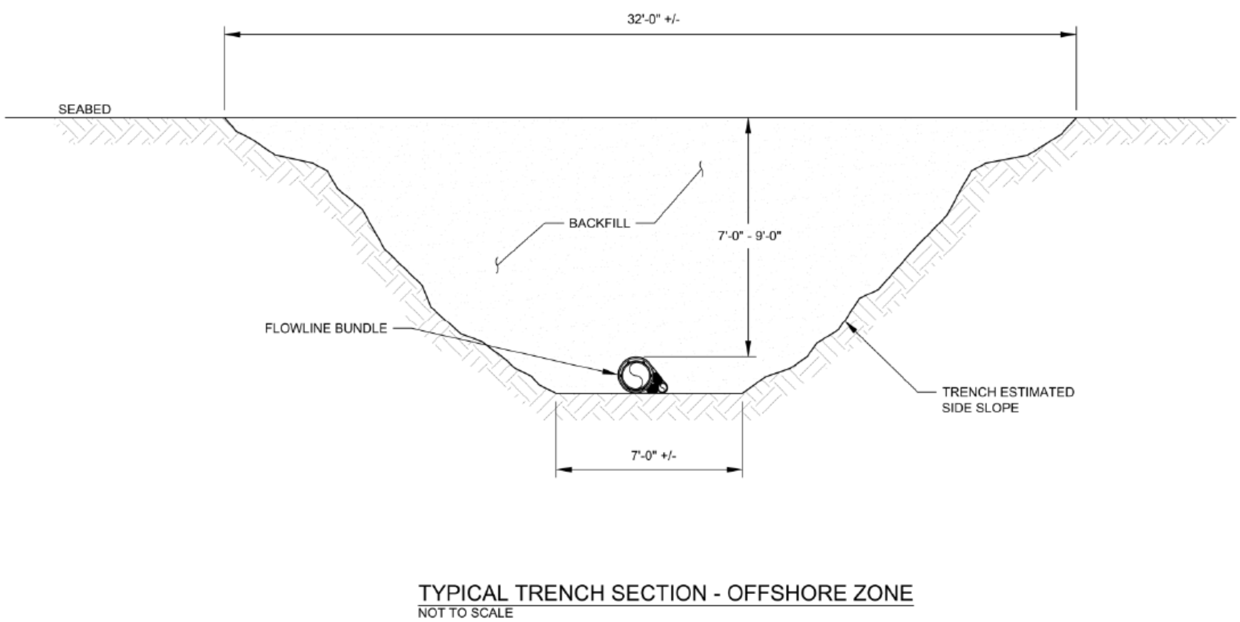


Figure 9. Typical offshore pipeline trench section (Hilcorp 2017).

At the pipeline landfall (where the pipeline transitions from onshore to offshore), Hilcorp will construct an approximately 0.6 ha (1.4 ac) trench to protect against coastal erosion and ice ride-up associated with onshore sea ice movement and to accommodate the installation of thermosiphons (heat pipes which circulate fluid based on natural convection to maintain or cool ambient ground temperature) along the pipeline. To support the trench, sheet pile will be installed at the pipeline shore crossing in the winter of year 2, when that equipment is deployed for the island sheet pile installation. Sheet pile would be temporary, and be installed onshore/at the coast (bottom fast ice) during ice covered conditions. Sheet piles would be installed to stabilize the ice around the pipeline trench, and would be installed and removed in a progressive fashion, as the pipeline is installed. Given the location of this proposed activity along the shoreline, underwater noise is not expected to propagate into the water column.

The onshore pipeline will cross the tundra for almost 2.4 km (1.5 mi) until it intersects the existing Badami pipeline system. The single wall 0.3 m (12-in) pipeline would rest on 150 to 170 vertical support members, spaced approximately 15 m (50 ft) apart to provide the pipeline a minimum 2.1-m (7-ft) clearance above the tundra. Hydro-testing (pressure testing using sea water) of the entire pipeline will be completed prior to commissioning.

Activities and equipment associated with pipeline installation that are likely to produce underwater noise are the use of trucks on ice roads, backhoe digging or use of an excavator, and Ditchwitch sawing of ice. Based on the Greene et al. (2008) sound source verification study conducted at Northstar, it is anticipated that trucks transiting ice roads will result in an average underwater sound pressure level of 179.1 dB re 1µPa at 1 m and an in-air sound source level of 74.8 dB re 20µPa at 100 m (SLR Consulting 2017). Backhoe digging is anticipated to have an average underwater sound pressure level of 177.7 dB re 1µPa at 1 m and an in-air sound source level of 78 dB re 20µPa at 10 m (Greene et al. 2008). The use of a Ditchwitch sawing through ice is anticipated to have an average underwater sound pressure level of 169.6 dB re 1µPa at 1 m and in-air sound source level of 76.3 dB re 20µPa at 100 m (Greene et al. 2008).

Leak Detection and Valves

Mass balance and pressure monitoring leak detection systems will be incorporated into the export pipeline design. These systems work in parallel and provide redundant measurements to ensure accuracy. It is expected that, under optimal conditions, these systems would be capable of detecting a leak of 1 percent of volumetric flow in the pipeline over a 24-hour period. Custody transfer metering will be located on the LDPI, and a flow meter will be located at the tie-in with the Badami Pipeline to enhance the performance of the leak detection system. Communication links to interface with the Badami and Endicott pipeline leak detection systems and controls will also be provided.

In addition to leak detection systems that are typically installed on single pipe systems, the Liberty offshore pipeline segment will use a pipe-in-pipe design that allows for real-time monitoring of the annulus between the two pipes. By evacuating air from the annulus and creating a vacuum, a leak can be detected by an increase in pressure. There will be natural fluctuations of pressure as a result of temperature changes that will be factored into the warning system, but the monitoring of the annulus is considered as best available technology as a method of monitoring for a leak.

Abnormal changes in the annulus temperature can also be used as a leak indicator. The fiber optic distributed temperature monitoring system will be able to identify slight changes in the temperature of the backfill, and therefore will provide early detection for any changes in environmental conditions (e.g., erosional events). In addition to these leak detection systems, Hilcorp will survey the pipeline route, conduct frequent meter proving, and implement operational procedures for pipeline shut-downs in the event a leak below the detection limits is suspected but not indicated by the leak detection systems.

Automated pipeline isolation valves will be located on the LDPI and at the proposed gravel pad at the Badami tie-in point. Each Liberty production well will be equipped with two actuated shutdown valves (SDVs) within the flow path of the producing wells; the Surface Safety Valve (SSV) and a Sub-Surface Safety Valve (SSSV). The SSV is an actuated valve on the wing valve of the tree and is the primary means of isolation from subsurface pressure sources during an upset condition. The SSSV is installed below surface in the tubing string to prevent uncontrolled flow in the event that a wellhead system fails. Both the SSV(s) and the SSSV(s) will be remotely actuated by automated control devices, and will stop the flow from a Liberty production well if the operating parameters are exceeded. These valves can also be closed locally or remotely if needed.

The Liberty production pipeline will be equipped with SDV(s) located on the LDPI prior to the pipeline leaving the island and at the shore crossing where the pipeline daylights, and at the tie-in point to the Badami Pipeline. These valves are remotely and automatically closed by the real-time leak detection system in case of a leak or other pipeline upset. These valves can also be remotely closed by a control room operator if needed.

2.1.1.4 Facility Construction

Facility construction includes the installation of all LDPI surface facilities, structures, and equipment on the LDPI in preparation for drilling, development, and production of the Liberty petroleum reserves. There is no in-water work associated with facility construction on the LDPI. The use of vessels and aircraft as part of facility construction are captured in Section 2.1.1.1, respectively.

The LDPI layout includes areas for staging, drilling, production, utilities, a camp, and a relief well. Permanent structures on the LDPI will be supported by driven steel piles and/or slab-on-grade foundations. Rig mats (portable platforms used to support equipment including drilling rigs, camps, tanks, and helipad) may be used in some areas (e.g., storage containers). The LDPI will have a helicopter landing pad and two docks to accommodate barges, a hovercraft, and small crew boats. It will also have ramps for ice road and amphibious vehicle access.

The LDPI design includes a seawater treatment plant, a sanitary wastewater facility, and a potable water treatment plant. Seawater will be treated and comingled with produced water and injected into the Liberty Reservoir to maintain reservoir pressure in a process called water-flooding. The treated seawater will also be used to create potable water and utility water used at the LDPI. Sanitary wastewater will receive secondary treatment through a membrane bioreactor. Remaining sewage solids will be incinerated on-island or stored in enclosed tanks prior to shipment to a treatment plant in Deadhorse.

Hilcorp plans to truck most modules, buildings, and materials for on-site construction to the North Slope via the Dalton Highway. However, materials could also be transported from Dutch Harbor to LDPI by sea-going barge. The foundation for new facilities at LDPI will be a combination of pad footings and piles, and will not depend on a permafrost substrate for direct support. A pad footing is a concrete block that is placed on the gravel. The facility is then placed or constructed on top of these footings or footers. There is no acoustic impact associated with placement of the footings. Foundation piles may also be used to level and stabilize facility structures. Approximately 700 to 1,000 foundation piles may be installed in the winter months within the interior of the island should engineering determine they are necessary for island support. Foundation piles will be installed in the interior of the gravel island area to provide a foundation for facility modules. Foundation pile driving is similar to the conductor pipe installation (referred to at Northstar as pipe driving for the facility foundation) conducted at Northstar in June and July 2000 (Richardson and Williams 2001). See “Pipe Driving” section above for more information on the acoustic sound source levels associated with pipe driving.

Workers and materials will be based at Endicott SDI; a hovercraft ramp and hangar will be installed there, and Hilcorp may create a ramp on the LDPI to facilitate winter ice road access to the LDPI. Additional onshore support will include use of water sources for ice roads and ice pads and development of an onshore gravel mine site. During construction, power will be generated by two diesel-fired generators. A redundant generator will be available for backup power generation. The LDPI facilities and camp will be powered by fuel gas-fired turbines using gas from one of the production wells.

2.1.1.5 Drilling

The LDPI well row arrangement is designed to accommodate up to 16 wells. Hilcorp plans to mobilize and install the drill rig in year 2. The drilling unit will be mobilized during open-water barge season of year 2, after the island is constructed and the well row is prepped for installation of the drilling unit. Re-assembly of the drilling unit with moving system and functional testing will continue through year end of year 2. Much of the drilling support equipment including the mud mixing facilities, the bulk mud and cement silos, and the grind and inject unit will be delivered during open-water season of year 2. Remaining equipment to commission the drilling facilities will be delivered as soon as the ice road is operational. As the drilling unit and drilling support equipment is nearing the commissioning phase, downhole drilling equipment and consumables will be delivered to the site. Subsurface drilling operations are scheduled to begin in year 2 using diesel engine powered generators (gen-sets) to power the drilling unit, and standalone diesel powered gen-sets for the drilling support equipment.

Once the 16-well drilling unit is commissioned, drilling operations will continue uninterrupted for approximately 2 years. However, drilling through the reservoir section will be limited to the summer open-water season (approximately July 15 through October 1) and the winter frozen-ice season, which begins with 18 in (1.5 ft) of ice (approximately November 5) and ends approximately June 1, as prescribed in the Oil Spill Response Plan (OSRP). Drilling through the reservoir section will be limited during periods of soft/broken ice. During the drilling season, Hilcorp will also implement measures to avoid impacts of vessel and aircraft traffic on the Cross Island bowhead whale hunt. The first 10 wells will be drilled in years 2 through 5. The remaining 6 wells may be drilled in years 6 through 23. It takes approximately 30 to 45 days to drill one well. In addition to drilling wells, drilling may also occur each year as part of well maintenance.

The first well drilled will be a disposal well for the cuttings re-injection and waste mud. Rock cuttings and excess drilling mud from this well will be stored on-site until the disposal well is completed and a grind and inject facility is constructed. Alternatively, cuttings and drilling mud may be transported to an existing onshore site for disposal. The second well will be a gas injector to allow produced gas to be re-injected into the reservoir as lift gas (re-injected gas used to increase fluid pressure). The remaining wells will be production wells. Once the wells are drilled and the drilling unit is out of the way, each well will have its own individual well house, similar to the design used at Endicott and Northstar.

Drilling will be done using a conventional rotary drilling rig, initially powered by diesel, and eventually converted to fuel gas produced from the third well. Gas from the third well will also replace diesel fuel for the grind and inject facility and production facilities. A location on the LDPI is designated for drilling a relief well, if needed.

Hilcorp plans to use either an existing platform-style drilling unit (Rig 428), which Hilcorp owns and has used recently in Cook Inlet, or a new drilling unit. Rig 428 is well-suited in terms of depth and horsepower rating to drill the wells at Liberty. Alternatively, Hilcorp may build a new drilling unit that would be designed to drill the Liberty development wells and to also be more portable and more adaptable to other applications on the North Slope. In either case, the drilling unit will be powered with new, low emission engines and new or re-conditioned drilling equipment.

Based on the sound source verification studies conducted at Northstar (Blackwell and Greene 2006), it is anticipated that drilling and production operations will result in an average underwater sound pressure level of 170.5 dB re 1µPa at 1 m during ice covered conditions and 151 dB re 1µPa at 1 m during the open-water season (SLR Consulting 2017). In-air sound source levels for drilling and production are expected to be 80 dB re 20µPa at 200 m (Blackwell et al. 2004a, SLR Consulting 2017).

2.1.1.6 Production and Operations

Production will commence once the initial facilities are constructed and the first three wells are drilled, and production will continue for the life of the project. Production, drilling, and facility installation activities will continue simultaneously until all the wells are drilled and in service. The initial production rate is expected to be in the range of 10,000 to 15,000 barrels of oil per day (BOPD). Hilcorp anticipates it will take about 2 years as additional wells are brought online to reach a peak flow rate of 60,000 to 70,000 BOPD from the reservoir.

Process facilities on the island will separate crude oil from produced water and gas. Gas and water will be injected into the Liberty Reservoir to provide pressure support and increase recovery from the field. A single-phase subsea pipe-in-pipe pipeline will transport sales-quality crude from the LDPI to shore, where an aboveground pipeline will transport crude to the existing Badami pipeline (see Section 2.1.1.3). From there, crude will be transported to the Endicott Sales Oil Pipeline, which ties into Pump Station 1 of the Trans Alaska Pipeline System for eventual delivery to a refinery.

Based on the sound source verification studies conducted at Northstar (Blackwell et al. 2004b, Blackwell and Greene 2006), it is anticipated that production operations activities will result in an average underwater sound pressure level of 154.5 dB re 1µPa at 1 m during ice covered conditions and 153 dB re 1µPa at 1 m during the open-water season (SLR Consulting 2017). In-air sound source levels for drilling and production are expected to be 80 dB re 20µPa at 200 m (Blackwell et al. 2004b, SLR Consulting 2017).

Emergency Response Training

Similar to the oil spill response training conducted each year at Northstar, emergency and oil spill response training activities will occur at various times throughout the year. Oil spill equipment deployment exercises will be conducted by Alaska Clean Seas (ACS) during both the ice-covered and open-water periods.

During the ice-covered periods, exercises will be conducted to practice tactics involving detection, containment, and recovery of oil on and under the ice. These exercises will mostly be on bottom-fast ice and will require snow machines and all-terrain vehicles. The spill equipment deployment exercise includes using various types of equipment to cut ice slots or drill holes through the floating sea ice. Typically, the snow is cleared from the ice surface with a skidsteer loader and snow blower that allows access to the ice. Two portable generators are used to power light plants at the exercise site. The locations and frequency for future spill drills or exercises will vary depending on sea ice conditions and training needs.

ACS also conducts spill response training activities during the open-water season from late July through early October. Vessels used as part of this training typically include Zodiacs, Kiwi Noreens, and Bay-class boats that range in length from 3.7 to 13.7 m (12 to 45 ft). Future exercises could include other vessels and equipment.

ARKTOS amphibious emergency escape vehicles may be stationed at Liberty as they are at Northstar Island. Each ARKTOS is capable of carrying 52 people. Training exercises with the ARKTOS are conducted monthly during the ice-covered period. ARKTOS training exercises are not conducted during the summer. Equipment and techniques used during oil spill response exercises are continually updated, and some variations relative to the activities described here are to be expected.

Annual Inspections and Geotechnical Surveys

Hilcorp will conduct annual inspections of the island slope through topographic and bathymetric surveys or periodic shallow geophysical or geohazard surveys to identify potentially hazardous conditions at or below the seafloor. Annual inspections will be completed over the pipeline corridor and along the island perimeter to assess impacts from strudel scours[1], ice events, or erosion. Hilcorp will implement actions based on these surveys, such as filling in strudel scours, or controlling shoreline or island erosion. Additional monitoring (via remotely-operated vehicles or sidescan sonar) may occur if reconnaissance surveys or other monitoring indicates that the pipeline has been exposed due to a strudel scour event.

Typical types of equipment and acoustic sources used for annual inspections or geohazard surveys include side scan sonar system that operates at 194 to 249 dB re 1 μPa at 1 m between 100 and 1,600 kHz; single-beam echosounder that operates at a frequency of 210 kHz with a

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[1] Strudel scours are drainages of water through sea ice at strudels (holes or cracks in the ice) that cause scouring depressions on the sea floor.

source level of 108 to 205 dB re 1 µPa at 1 m; and multi-beam echosounder with a source level between 216 to 242 dB re 1 µPa at 1 m and operating frequencies between 180-500 kHz. Seismic profiling with airguns or other impulse techniques (i.e., deep penetration seismic methods) is not part of the Proposed Action.

Wastewater Discharge

Section 301(a) of the Clean Water Act (CWA) provides that the discharge of pollutants to surface waters of the United States is prohibited except in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. Section 402 of the CWA establishes the NPDES permit program, which provides the EPA and authorized states the authority to control and limit the discharge of pollutants into waters of the United States. Hilcorp has applied for a NPDES permit for the discharge of waste streams associated with the LDPI. The LDPI is located offshore in Federal waters of the OCS; therefore, the EPA is the NPDES permitting authority for discharges from the LDPI.

Hilcorp has requested authorization to discharge five types of wastewater: sanitary and domestic wastewater, potable water treatment reject wastewater, seawater treatment plant wastewater, construction dewatering wastewater, and secondary containment dewatering wastewater from the facility to Stefansson Sound in the Beaufort Sea. Additional information on these discharges is available in the NPDES Permit technical fact sheet and Ocean Discharge Criteria Evaluation (EPA 2017) and the EIS (BOEM 2017b, 2018c).

Of the five wastewater discharges (Table 5), all except for the seawater treatment plant discharge, which occurs during the production phase of the project, are contingency discharges. For purposes of the NPDES permit, EPA defines a contingency discharge as, "an authorized discharge to navigable waters that occurs prior to construction of the waste disposal well, and/or when the well is offline or otherwise not available for injection during maintenance and/or testing activities (EPA 2017)."

Drilling fluids and drill cuttings associated with construction of the production wells will be disposed of through injection in a permitted disposal well; no surface water discharges of produced water, drilling fluids, and drill cuttings are planned under normal operations. Drilling fluids and cuttings may also be transported to an onshore site for disposal.

During the first 2 years of project construction, Hilcorp anticipates only discharging construction dewatering wastewater and secondary containment dewatering wastewater intermittently. There will be no discharge of sanitary and domestic wastewater, potable water reject wastewater, or seawater treatment plant wastewater during the construction phase. Sanitary and domestic wastewater will be hauled offsite to an onshore disposal facility and potable water will be brought to the project location from an existing onshore source.

During the production phase, the first well Hilcorp plans to drill at the LDPI is a waste disposal well. The drilling waste generated from this activity will be containerized onsite until the disposal well is operational. The sanitary and domestic wastewater, potable water treatment reject wastewater, construction dewatering wastewater, and the secondary containment dewatering wastewater will be injected downhole once the disposal well is operational. As such, during the production phase these discharges will only occur on a contingency basis, e.g., when the well is offline for maintenance and/or testing.

Table 5. Proposed NPDES discharges - average and maximum flow and treatment from the LDPI.

Wastewater	Type of Waste	Average / Maximum Flow[1]	Contingency Discharge
Sanitary and Domestic	Sanitary	5,000/20,000 gpd	Yes
Potable Water Treatment Reject	High concentration brine and dissolved solids	5,000/20,000 gpd	Yes
Seawater Treatment Plant	High concentration brine and dissolved solids	0.94/1.1 MGD	No
Construction Dewatering	Dewatering from excavated Areas	Minimal due to winter construction	Yes
Secondary Containment Dewatering	Petroleum and non-petroleum chemical storage area	Unspecified, gpd	Yes
[1]gpd =gallons per day, MGD =millions of gallons per day			

2.1.1.7 Decommissioning Activities

Hilcorp estimates the producing life of the Liberty field is 15 to 20 years. The estimation of the end of economic field life depends upon future oil and gas prices and operating costs. At the time the project is no longer economically viable, Hilcorp will begin abandonment and decommissioning procedures according to the permit conditions and regulations in force at that time. Hilcorp proposes to begin abandonment procedures when the project ceases to be economically viable, which at present is expected to occur in years 24 and 25. During production and operations, infill drilling or possible delineation success could extend the service life of the LDPI, production facilities, and pipeline system, but added longevity cannot be expected. Therefore, this opinion assumes decommissioning will occur in years 24 and 25. In addition, this opinion assumes that decommissioning activities in years 24 and 25 will be subject to existing or similar regulatory requirements. Decommissioning activities that differ from those activities analyzed in this opinion may require reinitiation of consultation (50 CFR 402.16).

Pursuant to existing regulations, Hilcorp must obtain approval of its decommissioning plan by submitting an application pursuant to 30 CFR 250.1703(a) and 30 CFR 250.1704. Regulations require the application to be submitted to BSEE and to meet the applicable requirements of 30 CFR part 250, subpart Q, Decommissioning Activities. Steps for decommissioning include: (1) approval before decommissioning wells and before decommissioning platforms and pipelines or other facilities; permanently plugging all wells; removing all platforms and other facilities; decommissioning all pipelines; and clearing the seafloor of all obstructions. In addition, all decommissioning activities must be done in a manner that is safe, does not unreasonably interfere with other uses of the OCS, and does not cause undue or serious harm or damage to the human, marine, or coastal environment (30 CFR 250.1703).

Hilcorp will plug and abandon the wells and remove production, transportation, and other surface facilities. Removal of facilities will occur in a reverse process from installation and construction, where the activities are expected to be similar to those activities associated with construction of the LDPI.

BSEE regulations provide specific requirements for permanent well abandonment (30 CFR 250.1710-250.1717), which require approval of an application for permit to modify and advance notice. The buried subsea pipeline will be abandoned in place subject to regulatory requirements at 30 CFR 250.1750-250.1754, which require approval of an application for pipeline decommissioning. Laws and regulations pertaining to ADNR and USACE approvals for this project also provide for discretion in termination and abandonment procedures.

BSEE regulations provide specific requirements for the removal of platforms and other facilities (30 CFR 250.1725-250.1731), which include production platforms, well jackets, single-well caissons, and pipeline accessory platforms. Some precedent has been set through approved abandonment of several islands built for exploratory drilling in state and Federal Beaufort Sea waters. These abandonment procedures have involved removing island slope protection, removing island facilities, removing wellheads, pilings, and other structures to below the mudline, and plugging and abandoning wells. Natural wave, ice, and current forces then gradually erode the island surface. This procedure was used for Tern Island, which is located about 2.4 km (1.5 mi) from the proposed LDPI.

After permanently plugging a well or removing a platform or other facility, BSEE regulations authorize specific methods for clearing obstructions from the site, and the regulations require verification and certification that the site is clear of obstructions (30 CFR 250.1740-250.1743).

Island and Facility Decommissioning

All installed surface facilities associated with the LDPI will be removed upon decommissioning or end of the facilities' useful life. The removal of platforms and facilities requires approval of a final removal application per 30 CFR 250.1725, which must include information required per 30 CFR 250.1727 (such as plans to protect sensitive biological features, an assessment of environmental impacts, mitigation measures to minimize impacts, and recent observations of marine mammals at the site).

Surface facilities will be de-energized, flushed of any oil and chemical residues if necessary (not all the lines carry oil), and removed. Modules will be removed in a reverse process from installation and transported to an offsite location to be reused, recycled, or disposed. Other installations will likely be removed by dismantlement.

Removal of facilities and abandonment of the wells is expected to require two winter seasons over a span of 18 months. Abandonment procedures will involve removing wellheads, pilings, and other structures to below the mudline, then plugging and abandoning the wells. Subsequently, the armoring and sheet piles will be removed, followed by testing the island for any contamination and remediating any contamination. After remediation of any contamination, the gravel will be left in place and allowed to naturally erode from waves, ice, and current forces. The removed armor from the LDPI may be used to enhance hard bottom habitat, or removed from the project area and recycled to another use or disposed of in an approved manner.

Pipeline Decommissioning

All surface lines will be de-energized and flushed (if necessary) prior to removal. The processes and standards for flushing are expected to be site-specific and become a key element of the final decommissioning plan (30 CFR 250.1704; 30 CFR 250.1751-250.1752).

The subsurface marine pipelines will be abandoned in place or continued to be used by Hilcorp or another entity. If the pipeline is not decommissioned in years 24 and 25, the pipeline system could be operated as a common carrier. This will allow for Hilcorp and/or another entity to use the pipeline for other future purposes, after which time it will be decommissioned and abandoned in place. To be decommissioned in place, the pipeline must not constitute a hazard (obstruction) to navigation and commercial fishing operations, unduly interfere with other uses of the OCS, or have adverse environmental effects (30 CFR 250.1750).

Before removing the pipeline, Hilcorp must submit a pipeline decommissioning application for approval (30 CFR 250.1751). When the subsurface marine pipeline is decommissioned, this buried pipeline will be flushed and filled with seawater, and Hilcorp will verify that all hydrocarbons or other contaminants have been removed, cut the ends of the pipeline off at the appropriate elevation, and permanently seal the ends. Marine lines will be identified to the United States Coast Guard for proper chart designations and navigation marking. Additional details of decommissioning the subsea buried pipeline will be determined in the permitting and/or decommissioning approval processes of the State of Alaska and the Department of Transportation, Pipeline and Hazardous Materials Safety Administration (BOEM 2017a).

2.1.2 Mitigation Measures

The action agencies and Hilcorp have identified the following mitigation measures in the Biological Assessment (BOEM 2017a), Development and Production Plan (Hilcorp 2017), the Request for an Incidental Take Authorization (Hilcorp 2018a), and NMFS Permits Division proposed rule (84 FR 24926; 84 FR 32697), that are required to minimize potential impacts from project activities. Additionally, the mitigation measures are separated into General Mitigation Measures (Section 2.1.2.1) that may aid in the recovery or protection of ESA-listed species, and Marine Mammal Mitigation Measures (Section 2.1.2.2) that aid in the recovery or protection of ESA-listed species under NMFS jurisdiction.

2.1.2.1 General Mitigation and Minimization Measures

BOEM identified the following general mitigation measures in the Biological Assessment (BOEM 2017a). These measures include: lease stipulations; design features and Best Management Practices (BMPs) committed to by the operator; and other BMPs or requirements of Cooperating Agencies that may or may not be included. NMFS's analysis, conclusions, and take estimates do not assume that the optional mitigation measures will be implemented. If they are implemented that may further reduce impacts of activities to listed resources compared to what has been analyzed in this opinion.

Lease Stipulations

Lease stipulations apply to DPPs, and the Liberty DPP must demonstrate planning and preparation to conduct development and production activities in conformity with all applicable lease provisions and stipulations (30 CFR 550.202 & 30 CFR 550.253). This subsection outlines the lease stipulations relevant to this opinion. Full text of the lease stipulations from the relevant lease sales is found on BOEM's website: https://www.boem.gov/Hilcorp-Liberty/ and Appendix F of the EIS (BOEM 2017b, 2018c). Lease sale stipulations use terms that refer to the structure and titles of the former MMS. Under current usage, MMS is now BOEM and/or BSEE and the term "Regional Supervisor, Field Operations (RS/FO)" refers to the Regional Supervisor, Leasing and Plans (RS/LP) at BOEM.

Stipulations Number 3 and Number 2 of Lease Sales 124 and 144, respectively

1. The lessee must develop a proposed orientation program for all personnel involved in the Liberty Development.
2. The program must address environmental, social, and cultural concerns that relate to the area, including the importance of not disturbing archaeological and biological resources and habitats.
3. The program shall be designed to avoid conflict with and increase the sensitivity and understanding of the personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program also shall include information concerning environmental impact avoidance and minimization measures.
4. The program shall be attended at least once a year by all personnel involved in on-site exploration, development, and production activities. The lessee shall maintain an on-site record of all personnel who attend the program for as long as the site is active, or for a period not to exceed 5 years.

Stipulation Number 4 of Lease Sale 124 and Number 3 of Lease Sales 144 and 202

1. Pipelines are required for transportation of hydrocarbons if the pipeline right-of-way can be obtained, if laying the pipeline is technologically feasible and environmentally preferable, and if pipelines can be laid without social safety net loss.
2. No crude oil production will be transported by surface vessel from the offshore production site except in cases of emergency.

Stipulation Number 6 of Lease Sale 202

1. Fuel transfers of 100 barrels or more occurring 3 weeks prior to or during bowhead whale migration will require pre-booming of the fuel barge prior to fuel transfers.

Stipulation Number 7 of Lease Sale 202

1. Lessees are required to implement lighting requirements that minimize the likelihood that spectacled or Steller's eiders will strike structures. Modification of lighting protocols will be undertaken if new information on bird avoidance measures becomes available. Lessees must also include a plan for recording and reporting bird strikes.

Design Features and BMPs Committed to by the Operator

Hilcorp has included the following design features and Best Management Practices (BMPs) in an effort to avoid and minimize potential effects the proposed action may have on the environment (BOEM 2017a).

Project Footprint

1. Use of directional drilling enables all proposed wells to be drilled from one island (drill pad).
2. The pipeline route was selected to avoid or minimize risks of strudel scour.
3. Processing on the LDPI takes advantage of newer air emission sources rather than using existing processing facilities.
4. The selected pipeline route avoids areas of mapped high density (≥ 25 percent) Boulder Patch.
5. The pipeline design minimizes the depth and size of the trench required.
6. The size and layout of the LDPI minimizes gravel requirements and seabed footprint, while still accommodating worker safety and spill prevention and response.
7. The LDPI has a mat slope armor protection system that extends from the island bench to the sea floor and a sheet pile wall to minimize the seabed footprint, overall gravel requirements, and long-term maintenance.
8. Process modules on the LDPI are a “fit-for-purpose” design, which will match equipment sizing and emissions sources to the reservoir and production needs of the Liberty reservoir.
9. Project gravel needs and the construction schedule are designed to minimize gravel pit size and operation time.
10. Heated facilities will be elevated above the gravel (onshore and on the LDPI) on pilings, have insulated floors, or have both in order to minimize building heat transmission to the permafrost.
11. Thermo-siphons will be installed where needed to prevent thaw subsidence.

Water Quality

1. Single phase, pipe-in-pipe design improves detection and containment of leaks.
2. Drilling muds will not be discharged, but stored on-site and disposed via injection when the disposal well is operational. Sanitary and domestic wastewater, potable water treatment reject wastewater, construction dewatering wastewater, and secondary containment dewatering wastewater will be injected into the waste disposal well when the well is operational. The waste disposal well will be the first well drilled and completed to facilitate waste water injection instead of discharge.

4. Hilcorp will comply with NPDES permit requirements for all authorized wastewater discharges from LDPI. To ensure protection of water quality and human health, the NPDES permit established effluent limitations and monitoring requirements for each of

the five (5) waste streams for which EPA has proposed to authorize Hilcorp to discharge from LDPI. The NPDES permit includes the following specific conditions and prohibitions for Hilcorp:

a. Develop and implement a BMP Plan to prevent or minimize the generation and the potential for the release of pollutants from the facility to surface waters.
b. Conduct Whole Effluent Toxicity testing on wastewater discharges from the potable water treatment system and the seawater treatment plant during periods when chemicals are used and when these waste streams are discharged to surface waters.
c. No discharge of floating solids, garbage, debris, sludge, deposits, foam, scum, or other residues of any kind.
d. No discharge of surfactants and dispersants.
e. No discharge of oil and grease.
f. No discharge any waste stream (including spills and other unintentional or non-routine discharges of pollutants) that are not part of the normal operation of the facility as disclosed in the permit application.
g. Comply with the most stringent effluent limitations for a discharge if that discharge is commingled with other authorized waste streams. If any individual discharge is not authorized, then a commingled discharge is not authorized.
h. Use phosphate-free and minimally toxic soaps and detergents for any purpose if domestic wastewater will be discharged to surface waters.

5. Hilcorp will use dedicated temporary storage systems and waste minimization to prevent waste from coming in contact with snow or rainwater.
6. Hilcorp will use drip pads beneath fuel transfers and engines to prevent drips or spills from contacting water or wetlands.
7. Hilcorp has committed in its permit application to employ the use of a membrane bioreactor to reduce the concentration of pollutants in the sanitary and domestic wastewater effluent.

Fish and Birds

1. To the extent practicable, construction will occur in winter when fewer fish species are present and when water currents are low, which will reduce total suspended solids distribution.
2. The LDPI and the pipeline from the LDPI to the Badami pipeline will be located to avoid impacts to habitat and to minimize alteration of ocean currents.
3. Seawater intake structures will be designed to prevent fish entrainment.
4. Island armoring will serve to reduce erosion and the spread of silt or gravel over fish habitat.
5. Hilcorp will develop a lighting plan to minimize the potential for bird strikes.
6. Towers and other structures on the LDPI will be designed to reduce nesting by predatory

birds.

7. Hilcorp will control food waste (e.g., use animal-proof dumpsters) to avoid attracting predators.
8. Marine traffic procedures will be implemented to avoid concentrations of molting waterfowl.
9. Seasonal air traffic controls (e.g., routing and minimum altitudes) over specific nesting and brooding areas (e.g., Sagavanirktok River Delta, Howe Island) will be implemented.
10. Bird use and wetlands mapping in the vicinity of the onshore gravel mine site and gravel pads will be considered in order to avoid high quality habitat, particularly for spectacled eiders and snow geese.

Subsistence

1. Criteria for island siting and design will be discussed with the Nuiqsut Whaling Captains' Association to minimize impacts to bowhead whales. Marine traffic to support the Proposed Action (e.g., routes, frequency, and schedule) will also be discussed to minimize impacts to bowhead whales.
2. Hilcorp will enter into a Conflict Avoidance Agreement with the Alaska Eskimo Whaling Commission (AEWC) and the Nuiqsut Whaling Captains' Association to mitigate impacts to subsistence whaling to the extent practicable.
3. To the extent practicable, local subsistence representatives will be employed during appropriate project phases.
4. Personnel skilled at protected species identification on support vessels will be employed, when warranted, to prevent vessel-marine mammal interaction during the open-water season.
5. Preferred marine routes will be established for transport of facilities and supplies to LDPI to minimize vessel-marine mammal interaction.
6. Minimum aircraft altitudes and routes for helicopters and other support aircraft, including UAS, will be established to avoid disturbing bowhead whales and other subsistence resources, consistent with safety requirements and weather considerations.
7. Hilcorp and contract personnel will be trained on the importance of subsistence and measures to avoid conflicts.

Requirements of Permitting Agencies

In addition to the design features and BMPs committed to by the operator, there are other federal, state, and local laws and policies that may be required for the Liberty project. This section describes the typical/standard measures that permitting agencies generally apply through their permitting process.

USFWS

Specific requirements from USFWS will be presented in the agency-approved documents, such as an LOA for the incidental take of marine mammals under the MMPA (for polar bears [*Ursus* *maritimus]*). General types of activities where requirements from USFWS will be applied include:

1. General offshore development and production activities;
2. Activities during the ice-covered season;
3. General vessel traffic;
4. Vessels in vicinity of polar bears;
5. Aircraft traffic in vicinity of polar bears;
6. Onshore development and production activities;
7. Exclusion zones / monitoring; and
8. Construction timing window for birds.

BSEE

Safety and prevention of pollution, including accidental oil spills, is the primary focus of BSEE OCS operating regulations. Pollution-prevention regulatory requirements for oil, gas, and sulphur operations in the outer continental shelf are in 30 CFR part 250, subpart C – Pollution Prevention and Control. These regulations require operators that engage in activities such as exploration, development, production, and transportation of oil and gas to prevent unauthorized discharge of pollutants into offshore waters (30 CFR 250.300). Operators shall not create conditions that will pose unreasonable risks to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean. If pollution occurs that damages or threatens to damage life (including fish and other aquatic life), property, any mineral deposits in leased and unleased areas, or the marine, coastal, or human environment, immediate corrective action must be taken and the control and removal of the pollution must be to the satisfaction of the BSEE Regional Supervisor. These regulations further mandate that the operator conduct daily inspections of drilling and production facilities to determine if pollution is occurring (30 CFR 250.301). If problems are detected, necessary maintenance or repairs must be made immediately.

In compliance with 30 CFR part 254, all owners and operators of oil-handling, oil-storage, or oil-transportation facilities located seaward of the coastline must submit an oil spill response plan (OSRP) to BSEE for approval that demonstrates the ability to respond quickly and effectively whenever oil is discharged (30 CFR 254.1). Owners or operators of offshore pipelines are required to submit an OSRP for any pipeline that carries oil, condensate that has been injected into the pipeline, or gas and naturally occurring condensate. Pipelines carrying essentially dry gas do not require an OSRP. In addition, a response plan that complies with 30 CFR part 254 may be required to be submitted with a DPP (30 CFR 550.250).

An OSRP must be submitted before an owner/operator may use a facility (30 CFR 254.2). BSEE must approve the OSRP before use of the facility, or to operate before approval of a submitted OSRP, the owner/operator must certify the capability to respond to the maximum extent practicable to a worst case discharge or a substantial threat of such a discharge. To continue operations, the facility must be operated in compliance with the approved OSRP. The owner/operator must carry out the training, equipment testing, and periodic drills described in the OSRP, and if there is a release of oil from the facility, the owner/operator must immediately carry out the provisions of the OSRP (30 CFR 254.5).

As a general rule, OSRPs must be reviewed every two years, and any resulting modifications must be submitted to BSEE (30 CFR 254.30). Revisions to an OSRP must be submitted to BSEE within 15 days whenever any of the following occur:

- A change occurs that significantly reduces an owner/operator's response capabilities;
- A significant change occurs in the worst-case-discharge scenario or in the type of oil being handled, stored, or transported at the facility;
- There is a change in the name or capabilities of the oil-spill-removal organizations cited in the OSRP; or
- There is a significant change in the appropriate area contingency plans.

To ensure plan holder readiness, BSEE will conduct routine inspections of the operator's facilities to ensure that the identified spill response resources are readily available and in the quantities and condition described in the OSRP. BSEE also will conduct government initiated unannounced exercises (GIUE) to test the operator's ability to carry out the provisions of the OSRP (BOEM 2017b). These exercises may take the form of tabletop exercises and/or equipment deployments. Government initiated unannounced exercises (e.g., oil spill drills) are infrequent, of short duration, (<8 hours), and utilize existing equipment. A facility will not participate in a BSEE initiated unannounced exercise more than once every 36 months, unless the results of previous exercises indicate that follow-up drills are warranted due to inadequate performance during a drill.

We assume these or similar regulatory requirements will apply and that changes in regulations may trigger reinitiation per 50 CFR 402.16.

2.1.2.2 Marine Mammal Mitigation Measures (Specific to NMFS Species)

The following mitigation measures could minimize potential impacts to ESA-listed species under NMFS's jurisdiction. We have identified which measures are currently required (e.g., design features and BMPs committed to by Hilcorp), and those that may be included by BOEM or other cooperating agencies as part of their project authorization processes. NMFS's analysis, conclusions, and take estimates do not assume that the optional mitigation measures will be implemented. If they are implemented that may further reduce impacts of activities to listed resources compared to what has been analyzed in this opinion.

Required Marine Mammal Mitigation Measures

Below are mitigation measures and design features agreed upon by Hilcorp (BOEM 2017b, 2018b, Hilcorp 2018a). We assume the following measures are required and will be implemented. If these measures are not incorporated into the proposed action by Hilcorp, the action agencies may need to reinitiate consultation on this action per 50 CFR 402.16.

General Required Marine Mammal Mitigation

1. The project will be located inshore of the barrier islands to remain inshore of the main fall migration path of the bowhead.
2. To the extent practicable, Hilcorp has planned to complete most of the LDPI construction activities during the winter months to reduce impacts to bowhead whales and subsistence hunting. As a contingency, some construction activities (pile driving, pipe driving, and slope shaping) may continue into the open-water season, and potential effects are analyzed in this opinion.
3. Operational procedures that minimize noise generation and the risk of vessel collision with marine mammals will be in place for project support vessels in transit during bowhead migration.
4. Food handling and waste management procedures to avoid creating attractants will be implemented.
5. Ice road, ice trail, and ice pad management (e.g., traffic controls, re-routings, etc.) will control access in areas where marine mammals may be encountered.
6. Toxic or hazardous material specifications, inventories, separation, confinement, and handling will be determined, documented, and communicated to appropriate personnel.
7. Hilcorp's Safety and Environmental Management Systems (SEMS) program will ensure emergency response and control plans are in place and ready for immediate implementation (30 CFR 250.1900-250.1933). The plans will be validated by drills and exercises carried out in accordance with a schedule defined by the SEMS training program (30 CFR 250.1915).
8. Island construction will include cutting of ice blocks and placement of gravel, island profiling, and armoring, and a vertical sheet pile wall will be installed (see Section 2.1.1). The wall protects the work surface of the island from ice and wave impacts. It also prevents most marine mammals from entering the work area. This design is similar to that at Northstar Production Island, constructed by BPXA in 2000.
9. In the event of an oil spill incident, the Incident Command System (ICS) will provide the on-scene management structure that guides response efforts. The responsible party (RP) will be prepared to support response efforts as part of ICS. Under the ICS structure, the operator will coordinate with the appropriate authorities within NMFS including the Regional Stranding Coordinator (RSC) or Headquarters Marine Mammal Health and Stranding Response Program (MMHSRP) staff (or their designee), to comply with the response effort in accordance with stranding agreements (SA) as described here and in NOAA's Marine Mammal Oil Spill Response Guidelines (Appendix G of the EIS (BOEM 2018c). The North Slope Borough Department of Wildlife Management (NSBDWM) located in Utqiaġvik (formerly known as Barrow), holds a SA, and is the appropriate regional point of contact in this region. The Alaska SeaLife Center (ASLC) is currently the only Oiled Wildlife Response Organization (OWRO) in Alaska that is permitted to clean and rehabilitate oiled wildlife under NMFS's jurisdiction:

- **Preparedness and Response Standards and Thresholds (Initial Immediate Response)**
  - Samples: In coordination with NMFS, Oil Spill Response Organizations (OSROs), and SA holders, the RP will be prepared to sample 50 live or dead pinnipeds (i.e., bearded seal, harbor seal, ribbon seal, ringed seal, spotted seal, northern fur seal, and/or Steller sea lion) during the first week following a spill incident, as well as prepared to sample 5 live or dead cetaceans (i.e., whales and porpoise) the first week. After the first week, the RP has the responsibility to fund the storage of carcasses, fund transport to approved facilities for analysis, and fund additional sampling or any live or dead pinnipeds or cetaceans. Sampling shall be performed by an individual or entity approved under NMFS Marine Mammal Health and Stranding Permit #18786.
  - Necropsy: In coordination with NMFS, OSROs, and SA holders, the RP will be prepared to fund and support the necropsy 50 dead pinnipeds and/or cetaceans by individuals authorized by NMFS. Necropsies shall be performed and samples stored by an individual or entity approved under NMFS Marine Mammal Health and Stranding Permit #18786. If mortalities exceed 50 animals, the RP has the responsibility to fund the storage of carcasses and fund transport to approved facilities for analysis.
  - Sample storage: Maintain level of readiness to store 1,000 marine mammal samples, which likely includes multiple samples from individual animals, and therefore, does not represent 1,000 animals. Samples shall be stored by an individual or entity approved under NMFS Marine Mammal Health and Stranding Permit #18786.
  - Cleaning/rehabilitation threshold: The following thresholds apply for live moribund animals whose condition can withstand transport.
    - *Pinnipeds:* The RP should maintain a level of readiness for 25 live pinnipeds to be cleaned and rehabilitated in coordination with NMFS, OSROs, and SA holders.
      - ✓ This applies to bearded, ringed, ribbon, spotted, harbor, and northern fur seals and Steller sea lions. However, capturing and cleaning oiled adult Steller sea lions is generally not feasible given their size and the difficulties in their collection and transport, as well as danger to response personnel.
      - ✓ It may not be feasible to capture oiled northern fur seals. Human safety must be a primary consideration as it may be dangerous to response personnel to capture oiled fur seal pups because of territorial bulls, and oiled adult fur seals would be extremely dangerous to handle, even if partially debilitated. Also, separating a pup from its mother temporarily may lead to abandonment.

- ✓ Authorized responders will use approved cleaning protocols and practices by species, which can be found in the Wildlife Protection Guidelines in the Alaska Unified Response Plan and NMFS National Marine Mammal Oil Spill Guidelines.
- ✓ All cleaned pinnipeds must be tagged by approved OWROs prior to release to monitor survival. Release of rehabilitated oiled wildlife will be coordinated with NMFS.

- *Cetaceans:* The RP should maintain a level of readiness for two live small cetaceans (e.g., young beluga whale, young killer whale, or porpoise) to be cleaned and rehabilitated. As stated in NOAA Marine Mammal Response Guidelines (Appendix G of the EIS [BOEM 2018c]), depending on the size and health of oiled cetaceans, euthanasia may be considered if rehabilitation is not in the best interest of the oiled animals.

- **Readiness Time Horizon**
  - Maintain readiness for additional sampling, necropsies, sample storage, and cleaning/rehabilitation for up to one year post-spill.
  - After the official closure of a spill response, RPs should remain prepared to support NMFS and wildlife response organizations to respond to oil-affected marine mammals under NMFS jurisdiction.
- **Authority**
  - Response authority for oiled marine mammals under NMFS jurisdiction is always retained by NMFS, and interventions can be authorized only by NMFS on a case by case basis. During a spill, authority to respond to oiled marine mammals may be granted under the NMFS Marine Mammal Health and Stranding Response Permit #18786 issued to Dr. Teri Rowles and her authorized NMFS Co-Investigators. Pre-authorization is not a component of this response structure.
  - In the future, NMFS plans to add a spill response component to language in Regional Stranding Agreements, which would allow agreement holders to respond to non-ESA listed MMPA species in the event of an oil spill. Response to ESA-listed marine mammals would still require authorization under NMFS permit #18786 as specified above.
- **Spill Response Network Model**
  - Preparedness and response shall be led through a NMFS approved contractor (e.g., ASLC) under U.S. Coast Guard's Oil Spill Removal Organization (OSRO) program, after obtaining authorization through NMFS permit #18786. NMFS will provide guidance regarding: 1) marine mammal response standards, 2) training requirements, and 3) regulatory pathways for response authorizations (e.g., authorizing marine mammal

responses pursuant to NMFS permit #18786). NMFS will maintain contact information on trained stranding network members and Incident Command System staff. NMFS-approved wildlife responders will facilitate preparedness for the stranding network as a primary field response participant, along with trained stranding network members. OSROs will need to work with NMFS-approved wildlife response organizations to ensure preparedness levels are sufficient for a rapid response to oiled marine mammal under NMFS jurisdiction. Currently, NMFS does not have the in-house capacity to lead field efforts, so will act in a guidance and oversight capacity through the Wildlife Protection Branch.

- **Adding Stranding Agreement Holders**

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

Ice-Covered Season Mitigation Measures

Unless otherwise noted, these measures apply to both ringed and bearded seals, and ice road, ice trail, and ice pad activities. Ice road/trail/pad mitigation measures are organized into the following categories: 1) Wildlife Training; 2) General Mitigation Measures (implemented throughout the ice road/trail/pad season, which occurs generally from December through May); 3) mitigation measures to be implemented after March 1st; and 4) Reporting Requirements.

Wildlife Training

Prior to initiation of sea ice road, trail, and pad construction activities, project personnel associated with ice road, trail, and pad construction, maintenance, or use (i.e., construction workers, surveyors, vehicle operators, security personnel, and the environmental team) will receive annual training[2] on seal avoidance mitigation measures that is appropriate for the work that they will perform. The annual training for all such personnel will include reviewing applicable portions of the company's Wildlife Interaction Plan[3], which include the following measures:

- Do not approach or interact with any wildlife, it is prohibited.
- When traveling the ice road/trail, follow directions of Security and posted signs.

[2] Training rosters can be made available to audit if requested.
[3] May also be referred to as a Wildlife Management Plan.

- Notify appropriate personnel if a seal is observed within 50 m (164 ft) or if a seal structure (i.e., breathing hole or lair) is observed within 150 m (about 500 ft) of the centerline of the ice road/trail; or the edge of the ice pad or on the ice pad.
- Stay in the vehicle and continue safely on if a seal is observed near the road/trail/pad.

In addition to reviewing the mitigation measures, additional wildlife training for personnel involved in ice road/trail/pad construction/maintenance or seal monitoring will include:

- How to identify ringed seal adults and pups;
- Seal life history;
- Habitat and diet;
- Presence in project area;
- Importance of lairs, breathing holes, and basking;
- Potential effects of disturbance; and
- Applicable laws and regulatory requirements.

General Mitigation Measures

These mitigation measures will be followed throughout the ice road/trail/pad season. They are based on the following assumptions:

- Ice road/trail/pad construction occurs from approximately December 1st to mid-February (or as soon as sea ice conditions allow safe access and permit such activity);
- Operations and maintenance generally occur from approximately mid-February through mid- to late May. Ringed seals begin to establish lairs in late March. Therefore, NMFS is requiring that ice road/trail/pad construction be initiated no later than March 1st to reduce the potential for disturbance to ringed seal birth lairs or dens; and
- Disturbance associated with construction prior to March 1st may deter pregnant seals from establishing lairs in the disturbed areas.

Winter sea ice road/trail/pad construction and use will begin prior to March 1st of each year (typically December through mid-February), which is before female ringed seals establish birthing lairs. Initiating on-ice activities early allows ringed seals to establish breathing holes and birthing lairs in undisturbed areas. Prior to establishing lairs, ringed seals are mobile and are expected to avoid the ice roads/trails/pads and construction activities.

The following mitigation measures will be implemented throughout the entire ice road/trail/pad season, including during construction, maintenance, active use[4], and decommissioning:

[4] There are periods during which ice road travel does not occur. During these periods, no activity would occur along the road and therefore, implementation of measures would not be necessary.

1. Ice road/trail speed limits will be no greater than 45 miles per hour (mph); speed limits will be determined on a case-by-case basis based on environmental, road conditions, and ice road/trail longevity considerations. Travel on ice roads and trails is restricted to industry staff.
2. Following existing safety measures, delineators will mark the roadway in a minimum of ¼-mile increments[5] on both sides of the ice road to delineate the path of vehicle travel and areas of planned on-ice activities (e.g., emergency response exercises). Following existing safety measures currently used for ice trails, delineators will mark one side of an ice trail a minimum of every ¼ mile. Delineators may also be used to mark the centerline of the roadway.
3. Corners of rig mats, steel plates, and other materials used to bridge sections of hazardous ice will be clearly marked or mapped using GPS coordinates of the locations.
4. Personnel will be instructed that approaching or interacting with ringed seals is prohibited.
5. If personnel encounter a ringed seal while driving on the road/trail, they will be instructed to remain in the vehicle and safely continue.
6. If a ringed seal is observed within 50 m (164 ft) of the center of an ice road or trail or within 50 m (164 ft) of the ice pad edge or on the ice pad, the company's Security personnel or staff member who observed the seal contacts the Environmental Specialist in accordance with the Wildlife Management Plan with the information requested in *Data Collection*.
    a. The location of the seal will be physically marked with a visible marker while maintaining a distance of at least 15 m (50 ft) from the seal. However, markers will be placed in a way that avoids marker placement more than 15 m (50 ft) from the edge of the ice road/trail/pad.
    b. The Environmental Specialist will relay the seal sighting location information to all ice road/trail/pad personnel and the company's office personnel responsible for wildlife interaction, following notification protocols described in the company-specific Wildlife Management Plan. All other data will be recorded and logged.
    c. The Environmental Specialist or designated person will monitor the ringed seal to document the animal's location relative to the road/trail/pad. All work that is occurring when the ringed seal is observed and the behavior of the seal during those activities will be documented until the animal is at least 50 m (164 ft) away from the center of the road/trail or from the edge of the ice pad or until the animal is no longer observed.

[5] The interval between delineators is specific to existing ice road safety measures and relates to how drivers assess and report weather and roadway conditions.

d. The Environmental Specialist or designated person will contact appropriate state and federal agencies as required[6] (see company-specific Wildlife Plans for notification details).

Other on-ice activities occurring prior to March 1st could include spill training exercises, pipeline surveys, snow clearing, and work conducted by vehicles such as PistenBullys®, snow machines, or rolligons. Prior to March 1st, these activities could occur outside of the delineated ice road/trail/pad and shoulder areas. Also during this period, all general mitigation measures will be implemented.

Mitigation Measures After March 1st

After March 1st and continuing until decommissioning of ice roads/trails/pads in late May or early June, on-ice activities can occur anywhere on sea ice where water depth is less than 3 m (10 ft) (i.e., habitat not suitable for ringed seal lairs and breathing holes). However, after March 1st on those sections of the ice roads/trails/pads where water depth is greater than 3 m (10 ft), all activities must occur within the boundaries of the driving lane/ice pad or shoulder area of the ice road/trail/pad (see Figure 10) and other previously disturbed areas (e.g., spill and emergency response areas, snow push areas), as long as personnel safety is ensured. In addition to the general mitigation measures, the following measures will also be implemented after March 1st:

1. Ice road/trail/pad construction, maintenance, and decommissioning will be performed within the boundaries of the road/trail/pad and shoulders, with most work occurring within the driving lane. Equipment travel will be limited to within the driving lane and shoulder when safety of personnel can be ensured (see Figure 10).
2. Ice road/trail/pad construction and maintenance activities will remain 50 m (164 ft) from a seal and 150 m (about 500 ft) from a seal structure (i.e., breathing holes and lairs) except under emergency conditions when blading or snow blowing is necessary. If blading or snow blowing must occur within 50 m (164 ft) from a seal or 150 m (about 500 ft) from a seal structure, the snow will first be pushed so that it is blown downwind of the animal or lair.
3. Vehicles will not stop within 50 m (164 ft) of identified seals or 150 m (about 500 ft) of known seal lairs.
4. Tracked vehicle operations will be limited to the previously disturbed ice trail areas when safety of personnel can be ensured. When safety requires a new ice trail to be constructed after March 1st, construction activities such as drilling holes in the ice to determine ice quality and thickness will be conducted only during daylight hours with good visibility. Ringed seal structures will be avoided by a minimum of 150 m (about 500 ft) during ice testing and new trail construction. Any observed ringed seal structures will be reported and marked as described in the *Data Collection and Reporting Sections*. Once the new

[6] As detailed in the Wildlife Management Plan.

ice trail is established, tracked vehicle operation will be limited to the disturbed area when safety of personnel is ensured.

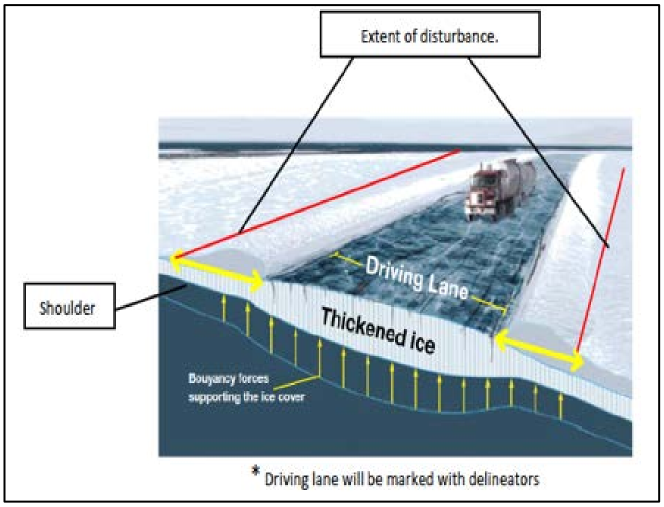


Figure 10. Ice Road Schematic

Monitoring Measures

The following monitoring and reporting activities will be implemented by Hilcorp, along with the mitigation measures described in the *Mitigation Measures After March 1st and Monitoring Measures Section*s, to avoid and minimize potential impacts to ringed seals during ice road/trail/pad construction, operation, and maintenance each year.

Ringed Seal Surveys

If an ice road or trail is being actively used[7], a dedicated observer will conduct a survey along the sea ice road/trail during daylight conditions with good visibility to observe if any ringed seals are within 150 m (about 500 ft) of the roadway corridor. These protocols will be followed:

1. Surveys will be conducted every other day during daylight hours. Survey protocol consists of driving the ice road/trail and stopping every ½ mile to observe the exposure area for approximately 5 minutes on either side of the corridor to check for the presence of seals.
2. Observers for ice road/trail activities need not be trained Protected Species Observers (PSOs), but they must have received the training described in the *Training Section* above and understand the applicable sections of the Wildlife Management Plan. In addition,

[7] Any days when there is no traffic on an ice road, monitoring for ringed seals will not occur in order to minimize potential for interactions with seals.

they must be capable of detecting, observing, and monitoring ringed seal presence and behaviors, and accurately and completely recording data.

3. When performing observations, observers will have no other primary duty than to watch for and report observations related to ringed seals during this survey. If the observer is driving a vehicle, then the survey must be performed when the driver stops, at periodic intervals sufficient to complete a thorough assessment of the area, given visibility conditions. If weather conditions become unsafe, the monitoring activity will be discontinued.

Communication and Monitoring Procedures for Seal and Seal Structure Sightings

If a ringed seal is observed within 50 m (164 ft) or if a seal structure (i.e., breathing hole or lair) is observed within 150 m (about 500 ft) of the centerline of the ice road/trail; or the edge of the ice pad or on the ice pad, the location of the seal or seal structure will be reported to the Environmental Specialist[8], who will then relay the sighting location information to all ice road personnel. In addition, the company's office personnel responsible for wildlife interaction would be notified following protocols described in each company's specific Wildlife Interaction Plan (see also *Reporting*). The following procedures will also be followed:

1. Construction, maintenance, or decommissioning activities associated with ice roads, trails, and pads will not occur within 50 m (164 ft) of the observed ringed seal, but may proceed as soon as the animal moves on its own more than 50 m (164 ft) from the activities or has not been observed within that area for at least 24 hours. Transport vehicles (i.e., vehicles not associated with construction, maintenance, or decommissioning) may continue their route within the designated road/trail without stopping.
2. As soon as practicable after the initial sighting, the Environmental Specialist or designated person will observe the ringed seal for approximately 15 minutes to document the animal's location relative to the road/trail/pad. All work that is occurring when the ringed seal is observed and the behavior of the seal during this observation period will be documented until the animal moves more than 50 m (164 ft) from the center of the road/trail, or more than 50 m (164 ft) from the edge of the ice pad, or is no longer observed. If the seal remains in the area after the 15-minute observation period, monitoring will continue every six hours during daylight conditions.
3. If a ringed seal structure (i.e., breathing hole or lair) is observed within 150 m (about 500 ft) of the ice road/trail or within 150 m (about 500 ft) of the edge of the ice pad or is on the ice pad, the location of the structure will be reported to the Environmental Specialist who will then carry out notification protocol described above.

[8] Also referred to as an Environmental Advisor in Wildlife Management / Interaction Plans.

a. The seal structure will be marked by placing a pole and flag or other easily visible marker about 15 m (50 ft) from the location of the lair.
b. Monitoring will continue every six hours during daylight conditions on the day of the initial sighting to determine whether a ringed seal is present. Monitoring will consist of observing the structure from a distance of at least 150 m (about 500 ft) for approximately 15 minutes each time. After the first 24 hours, monitoring for the seal will occur every other day the ice road/trail/pad is being used unless it is determined the structure is not actively being used (i.e., a seal is not sighted at that location during monitoring). A lair or breathing hole does not automatically imply that a ringed seal is present.
c. During this monitoring period, maintenance work will proceed cautiously as to minimize impacts or disturbance to area.

Data Collection

The Environment Specialist, or designated person, will record the following information during survey efforts and sighting events:

1. The date and start/stop time for each survey including effort in total number of hours of observation. This will include a summary of environmental conditions such as visibility that can affect ringed seal or lair detection;
2. Date and time of each significant event (e.g., seal or seal structure sighting) and subsequent monitoring;
3. Date, time, and duration for each sighting event;
4. Number of animals per sighting event; and number of adults/juveniles/pups per sighting event;
5. Primary, and, if observed, secondary behaviors of seals in each sighting event;
6. Geographic coordinates for the observed animals or structure (breathing hole or lair), with the position recorded by using the most precise coordinates practicable (coordinates must be recorded in decimal degrees, or similar standard, and defined coordinate system); and
7. Mitigation measures implemented to minimize impacts.

Reporting

Hilcorp will submit an annual monitoring report after the end of the ice road/trail/pad season to summarize the activities during ice road/trail/pad construction, maintenance, use, and de-commissioning that occurred that year. Records associated with any ringed seal observations and monitoring will be transmitted to NMFS prior to each subsequent ice road/trail/pad season (i.e., generally by late summer, prior to the subsequent ice road/trail season). This report should be submitted with (and consistent with the requirements for) the final reports required under *Data Collection and Reporting Requirements* (below).

If a specific mitigation or monitoring measure is implemented during the ice road/trail/pad activities (e.g., a breathing hole is monitored for seal presence), then a preliminary report of the activity will be submitted within 14 days after the cessation of that activity.

If a seal is observed within 50 m (164 ft) or a seal structure (i.e., breathing hole or lair) is observed within 150 m (about 500 ft) of the roadway during ice road/trail activities or the edge of the ice pad or on the ice pad, then notification to the Environmental Specialist and other staff and agency personnel will be undertaken as described above.

Annual Monitoring Report

Annual and final reports will be submitted via electronic mail to the appropriate NMFS staff including the NMFS AKR Protected Resources Division Supervisor and staff in OPR, Permits and Conservation Division in Silver Spring, Maryland.

Digital, queryable documents containing all observations and records, and digital, queryable reports will be submitted to: NMFS AKR Protected Resources Division, Bonnie Easley-Appleyard, at bonnie.easley-appleyard@noaa.gov and to OPR, Permits and Conservation Division, NMFS, and Jaclyn Daly, at Jaclyn.Daly@noaa.gov. In the event that this contact information becomes obsolete, call 907-271-5006 for updated reporting contact information.

Reporting of Unforeseen Events

In the unanticipated event that the specified activities along the ice road/trail/pad construction clearly causes the take of a marine mammal in a manner prohibited by this opinion's ITS or by the LOA, such as an unforeseen injury or mortality to a pinniped, the observer will report the incident to the Environmental Specialist, in accordance with their Wildlife Interaction/Management Plan, who would then relay that information to the OPR, Permits and Conservation Division, NMFS , and NMFS AKR Protected Resources Division (contact information provided above). This communication would occur as soon as practicable. A report documenting the incident would include:

- Time, date, and location (latitude/longitude) of the incident;
- Description of the incident;
- Water depth;
- Environmental conditions (e.g., wind speed and direction, and visibility);
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

In the event that an observer or Hilcorp discovers an injured or dead marine mammal, the cause of the injury or death is unknown, and the death is relatively recent (i.e., in less than a moderate state of decomposition), the incident would be reported to the OPR, Chief of the Permits and Conservation Division, NMFS in Silver Spring, Maryland (301-427-8401) and the Marine Mammal Network Alaska Stranding Coordinator in Alaska (Phone number 1-877-925-7773 or 1-877-9-AKR-PRD), as soon as possible. The report would include the same information identified in the paragraph above. Activities would be allowed to continue while NMFS reviews the circumstances of the incident. NMFS would work with Hilcorp to determine whether modifications in the activities are appropriate.

Under such circumstances that the injury or death is not associated with or related to Liberty project activities (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the incident would be reported to the OPR, Chief of the Permits and Conservation Division, NMFS or by email to the Alaska Stranding Coordinator within 24 hours of the discovery. Photographs, video footage (if available), and any other documentation of the stranded animal sighting will be provided to NMFS and the Marine Mammal Stranding Network.

Sheet Pile and Pipe Driving and Slope Shaping Mitigation Measures

1. Properly sized equipment will be used to drive pipe and sheet pile.
2. Pile and pipe driving at LDPI that cause sounds in the water above 120 dB will not be conducted during the fall subsistence hunt that occurs during bowhead whale migration (August 1 through end of hunt).
3. Hilcorp will use the soft-start technique at the beginning of impact pile/pipe driving each day, or if pile/pipe driving has ceased for more than 30 minutes. Soft-start procedures will be used prior to pile/pipe installation to allow marine mammals to leave the area prior to exposure to maximum noise levels. For impact driving, an initial set of three strikes will be made by the hammer at 40 percent energy, followed by a one-minute waiting period. This cycle is repeated two additional times for impact driving.
4. Marine mammal monitoring will be employed during all pile/pipe driving activities (impact and vibratory) during open-water conditions if pile/pipe driving must continue in open-water to complete construction. No observer monitoring for NMFS species is being considered (although observers will be looking for bears) during ice-covered season.[9]
5. Hilcorp will monitor Level A and Level B exclusion and disturbance zones outlined in Table 6. If a marine mammal(s) enters the Level A or Level B harassment zones, the animal(s) will be recorded as taken.

[9] For pile/pile driving activities during the ice-covered season with no observers monitoring, NMFS will assume the annual take estimated in this opinion has occurred, unless updated information on species density or ensonified area associated with construction activities is available.

Table 6. Summary of Level A and Level B monitoring and exclusion zones.

Stressor	Level B Monitoring Zones Underwater Noise (Open Water)	Level A Exclusion Zones Underwater (Open Water)
Vibratory Sheet Pile Driving	14,800 m	LF[10]: 50 m Phocid: 20 m
Impact sheet pile driving	2,050 m	LF: 1,940 m Phocid: 526 m
Slope shaping, armament installation	1,160 m	LF: < 10 m Phocid: < 10 m
Foundation piles/Conductor pipe impact driving	315 m	LF: 870 m Phocid: 240 m

6. Two on-island PSOs will be stationed at a location providing an unobstructed view of the predicted Level A exclusion zone. In addition, a third PSO will work closely with an aviation specialist to monitor the Level B zone using an UAS in real time (see Table 6). This third PSO and the UAS pilot will be located on the LDPI. If weather does not allow the use of a UAS, the third PSO may conduct marine mammal monitoring from a vessel in the water at the edge of the Level A zone (1.94 km). If the third PSO is placed on a vessel, they will be able to observe marine mammals at a distance of 1.5 km (0.9 mi) beyond the Level A zone. A fourth PSO and a second UAS pilot will rotate through these positions to allow sufficient breaks at least every 4 hours.
7. The PSOs will monitor the exclusion and disturbance zones before, during, and after pile/pipe driving, with PSOs located at the best practicable vantage points. Slope shaping may occur in open-water until approximately August 31st (see following bullet for Level B monitoring) of Year 2. Therefore, UAS will not be used after construction, unless these activities are necessary during decommissioning. If for any reason, pile or pipe-driving activities extend beyond the 15-day period or into Year 2, PSOs will be used to monitor the Level A and B zones. Hilcorp will determine the most appropriate observation platform(s) for monitoring.
8. The entire Level A exclusion zones must be visible for the entirety of the 30-min period. The waters will be scanned by PSOs (both land-based on the LDPI and using UAS) 30 minutes prior to commencing pile driving, pipe driving, and slope shaping at the beginning of each day, and prior to commencing pile/pipe driving after any stoppage of 30 minutes or greater. If marine mammals enter or were observed within the designated marine mammal exclusion zone 30 minutes prior to pile/pipe driving, the monitors will notify the on-site construction manager to not begin until the animal has moved outside the designated zone.
9. The waters will continue to be scanned for at least 30 minutes after sheet pile and pipe driving has completed each day, and after each stoppage of 30 minutes or greater.

[10] LF – low-frequency cetacean, i.e., bowhead whale.

10. Any marine mammal documented within the Level B harassment zone during sheet pile/pipe driving and slope shaping will constitute a Level B take (harassment) and be recorded.
11. If a bowhead whale is observed within the Level A zone, Hilcorp will shutdown pile driving activities immediately. If a ringed or bearded seal is observed in the Level A zone after pile driving has begun, it will be continually observed for a period not to exceed 20 minutes or until the pile driving stops (generally 10-20 minutes, see below). If the ringed or bearded seal remains in the Level A zone longer than 20 minutes, then activities will be shut down until the seal clears the area. Considering that the criteria for Level A harassment are sound exposure level (SEL) based, this observation period while a seal is in the Level A zone should not result injury, assuming that it does move out of the area (see Section 13.1.2). This approach to monitoring seals will prevent unnecessary delays in construction without resulting in harm to the seals.
12. The PSO monitoring the Level A zone will scan the waters using binoculars, spotting scopes, and unaided visual observation.
13. The PSO will use a hand-held range-finder device to verify that no marine mammals were in the areas ensonified as a result of all activities at the Project site.
14. Sheet pile and pipe driving activities will only begin and generally be conducted when it is possible to visually monitor marine mammals unless the operation began prior to poor visibility, with the assumption that no marine mammals will enter the Level A zone once the noise was active.
15. PSOs and the UAS will not be on duty during darkness; however, there will be no periods of darkness in the Project area until late August and current scheduling should prevent this condition from occurring. If poor environmental conditions restrict the PSO from observing the marine mammal Level A exclusion zone and Level B harassment zone (e.g. darkness, excessive wind or fog, high Beaufort state), sheet pile, pipe installation, and slope shaping activities will cease.

Vessel Traffic Mitigation Measures

1. Barging and other support marine traffic to LDPI will utilize routes in relatively shallow water inshore of the barrier islands to avoid the main migration path of the bowhead.
2. When weather conditions require, such as when visibility drops, support vessels must reduce speed and change direction, as necessary (and as operationally practicable), to avoid the likelihood of injury to marine mammals.
3. The transit of operational and support vessels through the North Slope region is not authorized prior to July 1. This operating condition is intended to allow marine mammals the opportunity to disperse from the confines of the spring lead system and minimize interactions with subsistence hunters. Exemption waivers to this operating condition may be issued by NMFS and USFWS on a case-by-case basis, based upon a review of seasonal ice conditions and available information on marine mammal distributions in the area of interest.
4. The transit route for the vessels will avoid known biologically important areas and designated critical habitat to the extent practicable.

5. All non-essential boat and barge traffic will be scheduled to avoid periods when bowhead whales are migrating through the area to where they may be affected by sound from the project. Any non-essential boat, hovercraft, barge, or aircraft will be scheduled to avoid approaching the harvest area around Cross Island during the bowhead whale subsistence hunting consistent with the Conflict Avoidance Agreement (CAA). All support vessel traffic outside the barrier islands must cease August 1, annually, until the official end of the hunt or until the quota has been met, whichever occurs first.
6. Vessels may not be operated in such a way as to separate members of a group of marine mammals from other members of the 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).
7. Vessels will avoid multiple changes in direction and speed when within 274 m (300 yds) of whales and also operate the vessel(s) to avoid causing a whale to make multiple changes in direction.
8. If the vessel approaches within 1.6 km (1 mi) of observed whales, except when providing emergency assistance to whalers or in other 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. Reducing vessel speed to less than 5 knots (9 km/hour) within 274 m (300 yards or 900 ft) of the whale(s).
    b. Steering around the whale(s) if possible.
    c. Operating the vessel(s) to avoid causing a whale to make multiple changes in direction.
    d. Checking the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged.
    e. Reducing vessel speed to 9 knots (17 km/hour) or less when weather conditions reduce visibility to avoid the likelihood of injury to whales.
9. Consistent with NMFS marine mammal viewing guidelines (https://alaskafisheries.noaa.gov/pr/mm-viewing-guide), operators of vessel should, at all times, avoid approaching marine mammals within 100 yards.
10. Vessels traveling between West Dock/Endicott and Foggy Island Bay shall not exceed speeds of 10 knots in order to reduce potential whale strikes.
11. Special consideration of North Pacific Right Whales and their critical habitat.
    a. Vessels will avoid transit within North Pacific right whale critical habitat (see Figure 11). If transit within North Pacific right whale critical habitat cannot be avoided, vessel operators must exercise caution and reduce speed to 10 knots (19 km/hour) while within North Pacific right whale critical habitat.
    b. Vessels transiting through North Pacific right whale critical habitat must have PSOs actively engaged in sighting marine mammals. Vessels will maneuver to keep at least 800 m (875 yards) away from any observed North Pacific right whale, and avoid approaching whales head-on consistent with vessel safety.

12. Vessels should take reasonable steps to alert other vessels in the vicinity of whale(s), and report any stranded, dead, or injured listed whale or pinniped to NMFS.
13. The vessel shall not approach within 5.5 km (3 nm) of a Steller sea lion rookeries or major haulouts.
14. All vessels to and from LDPI will watch for and avoid all marine mammals, will reduce speeds if a marine mammal is seen, and will report sightings to other vessels operating in the area.
15. Vessels and barges will not allow tow lines to remain in the water, and no trash or other debris will be thrown overboard, thereby reducing the potential for marine mammal entanglement.

Helicopter and Fixed Wing Mitigation Measures

1. Hilcorp will establish the shortest route from mainland to the LDPI that safety and weather conditions will allow.
2. Hilcorp will minimize potential disturbance to mammals from helicopter flights to support LDPI construction by limiting the flights to an established corridor from the LDPI to the mainland.
3. Except during takeoff and landing and in emergency situations, aircraft will maintain an altitude of at least 457 m (1,500 ft) within 305 m (100 ft) of whales or seals. Except during takeoff and landing, UAS will maintain a minimum altitude of 152 m (500 ft), unless a higher minimum altitude is determined to be necessary to minimize disturbance to marine mammals.
4. If a marine mammal is observed, then a horizontal distance of 305 m (1,000 ft) will be maintained between the aircraft and the observed marine mammal(s).
5. Helicopter flights should be limited to prescribed transit corridors. Helicopters shall not hover or circle above or within 457 m (1,500 ft) of groups of marine mammals.
6. If ice over-flights or similar repeated aerial surveys are conducted, a PSO shall be stationed aboard all flights and will document all marine mammal sightings.
7. Air traffic will be scheduled to avoid periods when bowhead whales are migrating through the area where they may be affected by noise.
8. Aircraft traffic will avoid flying over polynyas (open-water surrounded by ice) and along adjacent ice margins as much as possible to minimize potential disturbance to whales.
9. Air traffic will maintain a 1-mi radius when flying over areas where groups of ≥ 5 seals appear to be concentrated.
10. Aircraft will not land on ice within 1,400 m (4,593 ft) of hauled out pinnipeds.

UAS Monitoring Mitigation Measures

1. A UAS may be used to monitor the Level B zone associated with construction of the

LDPI. The pilot controlling the UAS will work closely with a PSO to monitor the Level B zone in real time.

2. The UAS will fly at an altitude of 152 m (500 ft; or other altitude determined appropriate based on the platform and as authorized by FAA and approved by NMFS). Hilcorp will comply with FAA regulations and if necessary, seek a waiver from the FAA to operate above 122 m (400 ft) and beyond the line of sight of the pilot. A minimum higher altitude may be necessary to avoid disturbance of marine mammals.
3. The UAS will not be used to circle marine mammals.
4. Ground control for the UAS will be located at LDPI, Endicott, or another shore-based facility close to Liberty.

Acoustic Monitoring

1. Hilcorp will conduct underwater acoustic monitoring during open-water conditions in years 2 through 5 for the purposes of conducting sound source verification. Acoustic monitoring will be conducted to document ambient noise conditions and to characterize the long-range propagation of sounds produced during the LDPI construction activities. 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 collected at Northstar.
2. The operator will conduct acoustic monitoring of sounds produced by project-related activities and acoustic monitoring of marine mammals within the project area.

PSO and UAS Operator Requirements

1. All PSOs will be trained in marine mammal identification and behaviors.
2. The PSO will have the following to aid in determining the location of observed listed species, to take action if listed species enter the exclusion zone, and to record these events:
   a. Binoculars;
   b. Range finder;
   c. GPS;
   d. Compass;
   e. Two-way radio communication with construction foreman/superintendent; and
   f. A log book of all activities which will be made available to BOEM and NMFS upon request.
3. The PSO will have no other primary duty than to watch for and report on events related to marine mammals.
4. The PSO and UAS operator will work in shifts lasting no longer than 4 hours with at least a 1-hour break between shifts, and PSOs and UAS operators will not perform duties as a PSO for more than 12 hours in a 24-hour period (to reduce PSO fatigue).
5. Experienced UAS operators will coordinate closely with a trained PSO during

monitoring.

Data Collection and Reporting Requirements

1. Hilcorp will require that PSOs use approved data forms.
2. PSOs will record detailed information about any implementation of shutdowns, including the distance of animals to the construction activity, description of specific actions that ensued, and resulting behavior of the animal, if any. At a minimum, the following information will be collected on the observer forms:
    a. Date and time that monitored activity begins or ends;
    b. Construction activities occurring during each observation period;
    c. Weather parameters (e.g., percent cover, visibility);
    d. Water conditions (e.g., sea state, tide state);
    e. Species, numbers, and, if possible, sex and age class of marine mammals;
    f. Description of any marine mammal behavior patterns, including bearing and direction of travel, closest point of approach, and distance from construction activity;
    g. Distance from construction activities to marine mammals and distance from the marine mammals to the observation point;
    h. Description of implementation of mitigation measures (e.g., shutdown or delay);
    i. Locations of all marine mammal observations; and
    j. Other human activity in the area.
3. The results of the Liberty marine mammal monitoring program, including estimates of “take by harassment” and “take by mortality,” will be presented in 90-day and final technical reports, with observer data submitted to NMFS in a digital spreadsheet format that can be queried. Reporting will address the requirements established by NMFS. The technical report(s) will include:
    a. Summaries of monitoring effort: total hours, total distances, and distribution of marine mammals 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 influencing detectability of marine mammals including sea state, number of observers, and fog/glare;
    c. Species composition, occurrence, and distribution of marine mammal sightings including date, water depth, numbers, age/size/gender categories, group sizes, and ice cover;
    d. Analyses of the effects of construction operations;
    e. Sighting rates of marine mammals during periods with and without construction activities (and other variables that could affect detectability);
    f. Initial sighting distances versus construction activity (impulse or vibratory driving

or slope shaping);

g. Observed behaviors and types of movements during construction activity;

h. Numbers of sightings/individuals seen during construction activity;

i. Distribution around the island during construction activity;

j. Estimates of "take by harassment" and "take by mortality";

k. If applicable, a summary of any injured or dead marine mammals discovered; and

l. Results and a complete description of methods used to survey for ringed seals will be submitted as part of the annual report. The annual monitoring report will summarize the type of activities conducted and completed, all findings and observations, and compare those findings to other similar reports (i.e., from Northstar and other Beaufort Sea offshore and nearshore developments).

4. UAS data collected will be provided to NMFS.

5. In the unanticipated event that the specified activity at LDPI causes the take of a marine mammal in a manner prohibited by the LOA and by this opinion's ITS, such as an unforeseen injury or mortality to a cetacean, or if authorized take is exceeded, 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 Alaska Region Office. Hilcorp must report any unanticipated or unauthorized take observed by its personnel or contractors, and this communication will occur as soon as practicable. In the event of a ship strike the PSO will report the incident to NMFS and Hilcorp. Following such an event (including unanticipated or unauthorized take, and take that exceeds that authorized), formal consultation will be reinitiated immediately. A report documenting marine mammal takes will be submitted in a digital format that can be queried, and will include:

    a. Time, date, and location (latitude/longitude) of the incident;

    b. Description of event;

    c. Name and type of vessel involved (if applicable);

    d. Vessel's speed during and leading up to the incident (if applicable);

    e. Description of the incident;

    f. Status of all sound source use in the 24 hours preceding the incident;

    g. Water depth;

    h. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);

    i. Description of all marine mammal observations in the 24 hours preceding the incident;

    j. Species identification or description of the animal(s) involved;

    k. Fate of the animal(s); and

    l. Photographs or video footage of the animal(s) (if equipment is available).

6. In the event that an observer or Hilcorp discovers an injured or dead marine mammal in which the cause of the stranding, injury, or death is unknown, and the death is relatively recent (i.e., the animal has undergone less than moderate decomposition), Hilcorp will report the incident to the NMFS Chief of the Permits and Conservation Division, Office of Protected Resources in Silver Spring, Maryland, and the Alaska Stranding Coordinator in Anchorage, Alaska, as soon as possible. The report will include the same information identified in the paragraph above. Activities will be allowed to continue while NMFS reviews the circumstances of the incident. NMFS will work with Hilcorp to determine whether modifications in the activities are appropriate.
7. When an injured or dead marine mammal is encountered, and the stranding, injury, or death is not associated with project activities, Hilcorp will report the incident to the NMFS Chief of the Permits and Conservation Division, Office of Protected Resources and the Alaska Stranding Coordinator within 24 hours of the discovery.
8. Hilcorp will make efforts to obtain and provide photographs or video footage of the stranded, injured, or dead marine mammal.

2.1.2.3 Additional Mitigation Measures in the Liberty DPP EIS

BOEM analysts identified additional mitigation measures which, if implemented, may further reduce potential impacts. These additional mitigation measures are described below as well as in Appendix C of the EIS (BOEM 2018c). NMFS's analysis, conclusions, and take estimates do not assume that the optional mitigation measures will be implemented. If they are implemented that may further reduce impacts of activities to listed resources compared to what has been analyzed in this opinion.

1. Solid Ice Condition- Hilcorp will adhere to the following condition to minimize the likelihood of an oil spill reaching open-water:
    - Reservoir drilling will only be conducted when at least 18" of ice exists in all areas within 500' of the LDPI. The period of time during which reservoir drilling shall be allowed will typically be between October 21 and June 1, although this time period may vary and is dependent on ice thickness and extent as described.
    - "Reservoir drilling" is defined as occurring between the initial penetration beyond the shoe (base) of the last casing string above the Kekiktuk Formation and the base of the formation (i.e., any exposure of the Kekiktuk Formation to an open (uncased) wellbore constitutes "reservoir drilling"). This reservoir drilling restriction applies only to the development operations contemplated in the Liberty DPP.
2. In accordance with the CAA, to reduce potential disturbance to Cross Island subsistence whaling activities, the following activities are prohibited from August 1 through the end of the hunt: (1) pile-/pipe-driving activities at the LDPI; and (2) marine vessel traffic seaward of the barrier islands. These activities can resume after the Nuiqsut bowhead whale quota of four whales is met or after the Cross Island-based whalers officially end their whaling activities for the season. In the event that Nuiqsut whalers communicate an intent to conduct subsistence whaling activities south of Narwhal Island, Hilcorp must make all reasonable efforts to minimize

conflicts between operations (including marine vessel traffic) and subsistence hunting activities.

Action Area

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

The action area for this biological opinion will include: (1) marine and coastal sites proposed for construction of the LDPI; (2) sound propagation buffer around LDPI; (3) transportation routes with sound buffer; and (4) areas potentially affected by terrestrial or marine spills or within which ESA listed species (under NMFS jurisdiction) may be affected by disturbance (Figure 11).

BOEM is proposing to authorize Hilcorp to construct and operate an artificial gravel island, a subsea pipeline, and onshore support facilities to recover petroleum reserves from three OCS Federal leases (OCS-Y-1650, OCS-Y-1585, and OCS-Y-1886) in the Beaufort Sea, northeast of the Prudhoe Bay Industrial Center (Deadhorse), on the North Slope of Alaska. The work surface of the LDPI would be approximately 9.3 ac (3.8 ha) and the seabed footprint would be approximately 24 ac (9.71 ha). Construction of the LDPI would require approximately 929,900 cubic yards (cy) of gravel from a gravel site onshore. The LDPI portion of the action area in the Beaufort Sea includes the area surrounding the LDPI, including Foggy Island Bay, Stefansson Sound, and Prudhoe Bay. It also includes project related onshore facilities along the Alaska coastline: a hovercraft shelter, small boat dock, ice pads, ice trails, and ice roads will be constructed, and construction and operation of a pipeline connecting LDPI to the existing Badami Pipeline (BOEM 2017a).

Within the offshore portion of the action area, the loudest underwater sound source with the greatest propagation distance is anticipated to be vibratory sheet pile installation. Received levels from vibratory pile driving with an average source level of 221 dB may be expected to decline to 120 dB re 1 μPa (rms) at a maximum distance of 17.5 km (11 mi) of LDPI (SLR Consulting 2017).[11] The 120 dB isopleth was chosen because that is when we anticipate pile driving noise levels would approach ambient noise levels (i.e., the point where no measurable effect from the project would occur). While project noise may propagate beyond the 120 dB isopleth, we do not anticipate that marine mammals would respond in a biologically significant manner at these low levels and great distance from the source.

The marine transit route includes the route that vessels will take when transiting from Dutch Harbor to the LDPI. The marine transit route crosses the Bering Sea, Chukchi Sea, and Beaufort

[11] The sound propagation buffer component of action area was defined using the maximum anticipated propagation distance (17.5 km). However, for purposes of analyzing take, the average propagation distance was used (14.8 km), which is considered reasonably certain to occur.

Sea (BOEM 2017a). For the marine transit route, 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. 1995c).

However, when Hilcorp, in coordination with NMFS, performs the sound source verification study to determine the actual area that would be ensonified to at least 120 dB re 1μPa$_{rms}$, the size of the action area (and thus the area within which effects to listed species are expected) may be altered to reflect those site-specific measurements (see Section 2.1.2).

The Oil Spill Risk Analysis (OSRA) looked at probabilities of various sized spills contacting waters and shorelines along the Beaufort Sea. Based on these possible spills, the boundary of the action area extends into part of the bowhead whale fall migration biologically important area. Additional information on hypothetical oil spill trajectories can be found in Appendix A of the EIS (BOEM 2018c), and below in Section 6.2.4.

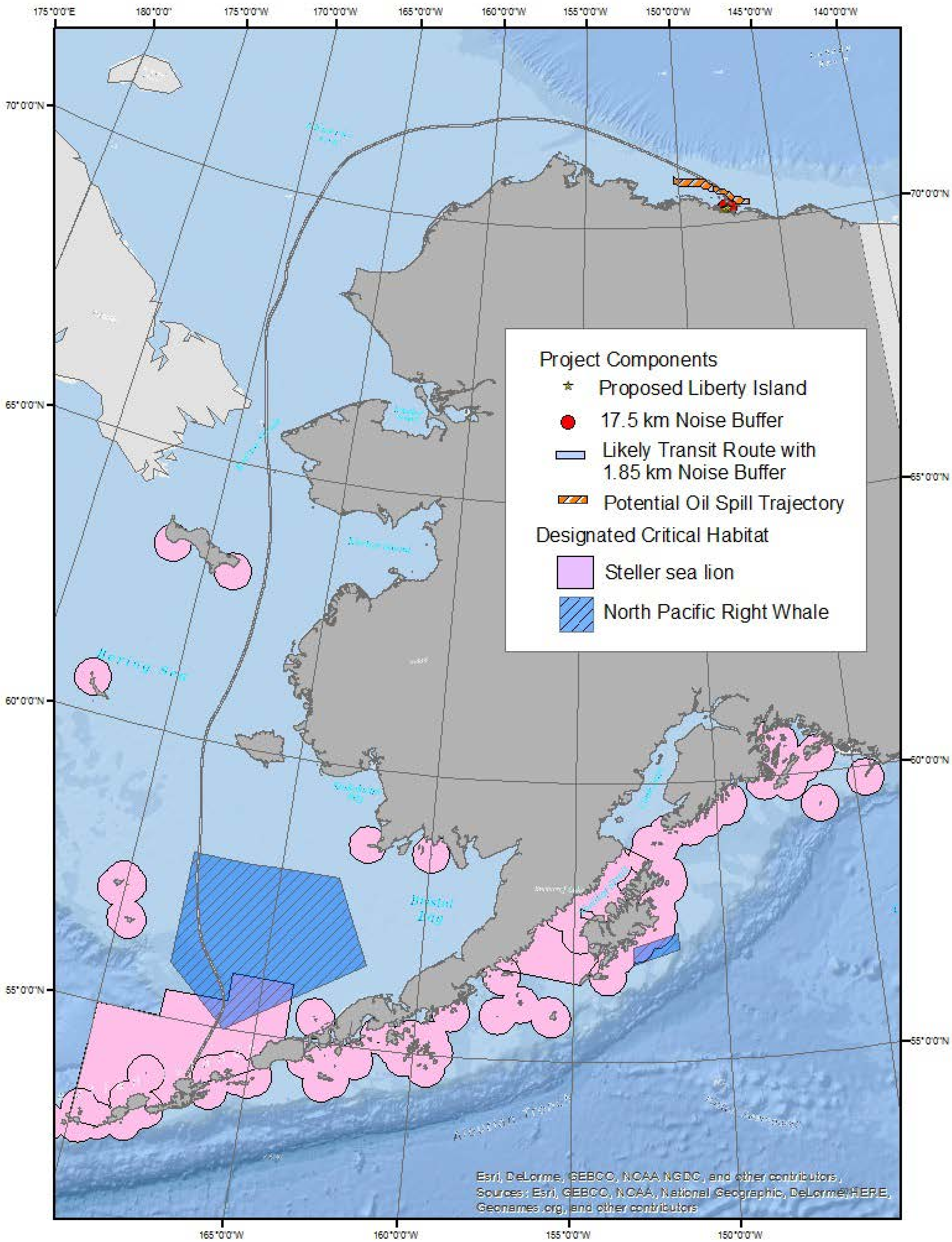


Figure 11. Action Area includes: LDPI construction site (star), sound propagation buffer (red), transit area with sound buffer (grey), and potential spill areas.

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

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

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

We use the following approach to determine whether the proposed action described in Section 2.1.1 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) appreciably diminish 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 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.

4 RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

Ten species of marine mammals listed under the ESA under NMFS's jurisdiction may occur in the action area. The action area also includes designated critical habitat for two species. This opinion considers the effects of the proposed action on these species and designated critical habitats (Table 7).

Table 7. Listing status and critical habitat designation for marine mammals considered in this opinion.

Species	Status	Listing	Critical Habitat
Bowhead Whale (*Balanea mysticetus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Blue whale (*Balaenoptera musculus*)	Endangered	NMFS 1970 35 FR 18319	Not designated
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
North Pacific Right Whale (*Eubalaena japonica*)	Endangered	NMFS 2008, 73 FR 12024	NMFS 2008, 73 FR 19000
Sperm Whale (*Physeter macrocephalus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Ringed Seal, Arctic Subspecies (*Phoca hispida hispida*)	Threatened	NMFS 2012, 77 FR 76706	Not designated
Bearded Seal, Beringia DPS (*Erignathus barbatus nauticus*)	Threatened	NMFS 2012, 77 FR 76740	Not designated
Steller Sea Lion, Western DPS (*Eumatopias jubatus*)	Endangered	NMFS 1997, 62 FR 24345	NMFS 1993, 58 FR 45269

Species and Critical Habitat Not Likely to be Adversely Affected by the Action

If an action's effects on ESA-listed species will be insignificant, discountable, or completely beneficial, we conclude that the action is not likely to adversely affect those species. Insignificant effects relate to the size of the impact and are those that one would not be able to meaningfully measure, detect, or evaluate, and should never reach the scale where take occurs.

Discountable effects are those that are extremely unlikely to occur. Similarly, if proposed activities are not likely to destroy or adversely modify critical habitat, further analysis is not required.

4.1.1 Blue Whale, North Pacific Right Whale, Sperm Whale, Fin Whale, Humpback Whale, and Steller Sea Lion Western DPS

The route proposed for seagoing project barges and tugs transiting between Dutch Harbor and the North Slope (marine transit route) overlaps with the ranges of the blue whale, North Pacific right whale, sperm whales, fin whale, humpback whale (Western North Pacific DPS and Mexico DPS), and western DPS Steller sea lions. Potential effects from project vessel traffic on these ESA listed species includes auditory and visual disturbance and vessel collision.

Project vessels would have a short-term presence in the Bering and Chukchi Seas as they transit between Dutch Harbor and the North Slope. NMFS is not able to quantify existing traffic conditions across these seas to provide full context for the maximum of up to 14 vessel trips per year (year 4), although there will be fewer vessel trips in other years, or up to 48 vessel trips over the life of the project (see Table 3). However, Automatic Identification System (AIS) data were recorded from 532 vessels in the Bering Strait and northern Bering Sea region from 2013 through 2015 (Nuka Research and Planning Group 2016), and from 250 vessels in U.S. waters north of the Pribilof Islands in 2012 (ICCT 2015). The number of proposed vessel trips along the marine transit route each year would be very small in comparison to the existing level of vessel traffic in the action area.

Hilcorp will implement mitigation measures (Section 2.1.2) to minimize or avoid auditory and visual disturbance and potential vessel collision during tug and barge activities. These mitigation measures include, but are not limited to, maintaining a vigilant watch for listed whales and pinnipeds and avoiding potential interactions with whales by implementing a 5 knot (9 km/hour) speed restriction when within 300 yards (274 m) of observed whales. Project vessels will also avoid approaching within 3 nm (5.5 km) of known Steller sea lion rookeries and major haulouts. In addition, vessels will take reasonable steps to alert other vessels operating in the vicinity of whale(s), and will report any dead or injured listed whales or pinnipeds. Hilcorp will either avoid transiting within designated North Pacific right whale critical habitat or in the event that such transit through critical habitat cannot be avoided, vessel operators will exercise extreme caution and observe the 10 knot (19 km/hour) vessel speed restriction. Additionally, Hilcorp will have PSOs actively engaged in sighting marine mammals, and vessel operators will maneuver vessels to keep at least 800 m (875 yards) away from any observed North Pacific right whales and 100 yards (91.4 m) from other marine mammals and to avoid approaching whales head-on.

Although some marine mammals could receive sound levels in exceedance of the acoustic threshold of 120 dB from the vessels or be disturbed by the visual presence of barges and tugs, take is unlikely to occur. NMFS has interpreted the term “harass: in the Interim Guidance on the ESA Term "Harass" (Wieting 2016) as 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.” While listed marine mammals will likely be exposed to acoustic stressors from barging activities, the nature of the exposure (primarily tug noise) will be low-frequency, with much of the acoustic energy emitted by project vessels will be at frequencies below the best hearing ranges of the marine mammals expected to occur within the action area. In addition, because vessels will be in transit, the duration of the exposure will be temporary. NMFS anticipates that at 10 knots, vessels will ensonify a given point in space to levels above 120 dB (the acoustic threshold for behavioral disturbance from continuous sound; Section 6.1.1.1) for less than 9 minutes. The project vessels will emit continuous sound while in transit, which will alert marine mammals before the received sound level exceeds 120 dB. Therefore, a startle response is not expected. Rather, slight deflection and avoidance are expected to be common responses in those instances where there is any response at all. The implementation of mitigation measures, as specified in Section 2.1.2, is expected to further reduce the number of times marine mammals react to transiting vessels.

The factors discussed above, when considered as a whole, make it extremely unlikely that transiting vessels would elicit behavioral responses by blue whales, North Pacific right whales, sperm whales, fin whales, Western North Pacific DPS humpback whales, Mexico DPS humpback whales, or Western DPS Steller sea lions that would rise to the level of harassment as interpreted in NMFS guidance (Wieting 2016) relative to take by harassment under the ESA, and such effects are, therefore, insignificant.

In addition, based on the extremely small number of North Pacific right, and sperm whales in the Bering Sea, and limited number of transits associated with the project, we do not anticipate spatial overlap between these species and vessel operations. Thus, the potential for exposure is extremely unlikely to occur, and the risks posed by the proposed action to Western North Pacific right, and sperm whales are considered discountable.

Vessels transiting the marine environment have the potential to collide with, or strike, marine mammals (Laist et al. 2001, Jensen and Silber 2003). From 1978 to 2012, there were at least 108 recorded whale-vessel collisions in Alaska, with the majority occurring in Southeast Alaska (Figure 12; Neilson et al. 2012). Among larger whales, humpback whales were the most frequently documented victims of ship strikes, accounting for 86 percent of all reported collisions. Fin whales accounted for 2.8 percent of reported collisions, gray whales 0.9 percent, and sperm whales 0.9 percent. The probability of strike events depends on the frequency, speed, and route of the marine vessels, and the distribution and density of marine mammals in the area, as well as other factors. Vanderlaan and Taggart (2007) used records of large whale-vessel strikes to develop a model of the probability of lethal injury based upon vessel speed. The model projected that the chance of lethal injury to a large whale struck by a vessel travelling at speeds over 15 knots (28 km/hour) is approximately 80 percent, and that this probability drops to about 20 percent for vessels travelling between 8.6 knots (16 km/hour) and 15 knot (28 km/hour).

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 2008). Despite all of the traffic in and around rookery and haulout locations near Dutch Harbor, there have been no reported ship strikes of Steller sea lions in Alaska. Moreover, the Steller sea lion population in and around Dutch Harbor has been increasing at about 2 to 3 percent per year, despite ongoing vessel traffic (Fritz 2012b, Muto et al. 2017).

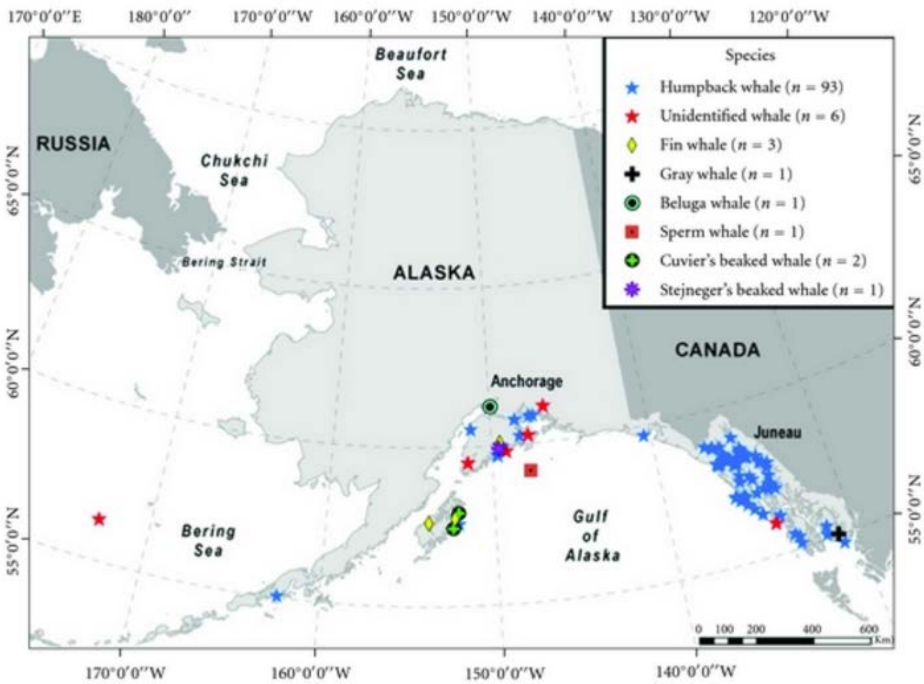


Figure 12. Location of whale-vessel collision reports in Alaska (*n* = 108) by species 1978–2011, from Nielson et al. (2012).

Based on the limited annual number of vessel trips between Dutch Harbor and the North Slope, the transitory nature of this vessel traffic, mitigation measures in place to minimize or avoid effects of transiting vessels on cetaceans and pinnipeds, and decades of vessels transiting in the Bering and Chukchi Seas with only a single report of a ship strike, NMFS concludes that a project vessel striking a blue whale, North Pacific right whale, sperm whale, fin whale, Western North Pacific DPS humpback whale, Mexico DPS humpback whale, or Western DPS Steller sea lion is extremely unlikely to occur, and thus the effects are discountable

In summary, NMFS concurs that the proposed action is not likely to adversely affect the blue whale, North Pacific right whale, sperm whale, fin whale, humpback whale Western North Pacific DPS and Mexico DPS, and Steller sea lions Western DPS. These species are not discussed further in this opinion.

4.1.2 North Pacific Right Whale and Steller Sea Lion Critical Habitat

North Pacific right whale critical habitat (Figure 13) was designated in areas where this species is known or believed to feed in the eastern Bering Sea and Gulf of Alaska (73 FR 19000; April 8, 2008). The PBFs deemed necessary for the conservation of North Pacific right whales include the presence of specific copepods (*Calanus marshallae, Neocalanus cristatus*, and *N. plumchris*), and euphausiids (*Thysanoessa Raschii*) that act as primary prey items for the species.

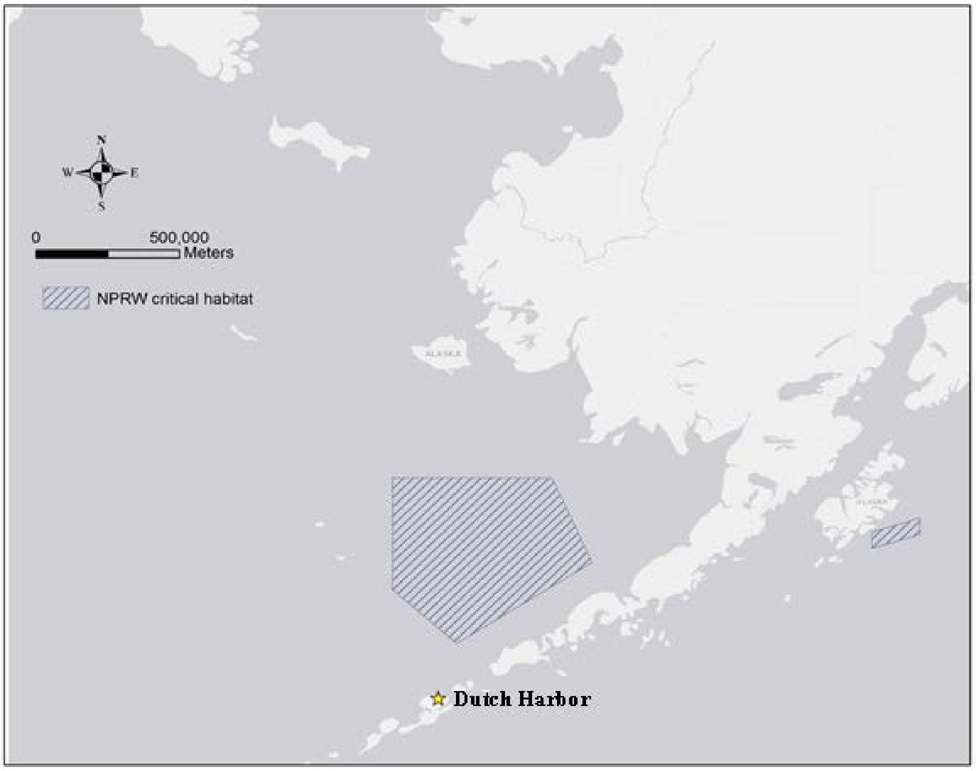


Figure 13. North Pacific right whale critical habitat.

The potential effects of the action that may overlap with North Pacific right whale critical habitat include: vessels transiting to and from Dutch Harbor and LDPI, exposure to spilled or otherwise-discharged fuel or other chemicals, and acoustic disturbance. While vessels associated with the action may enter designated critical habitat, vessel traffic is not anticipated to affect aggregations of copepods or euphausiids, and therefore will not affect the PBFs associated with North Pacific right whale critical habitat. In addition, given the small number of trips by project vessels per year (a maximum of two vessels per year for certain years of the project) and the low likelihood of a spill occurring, we find it extremely unlikely that a fuel spill, other chemical spill, or discharge will occur as a result of this vessel traffic that would have more than a de minimis effect on the PBF for the critical habitat. Even if a small spill were to occur in this critical habitat, it would be expected to evaporate, dissipate, or become entrained within 24 hours, such that any effects to this PBF would be insignificant. We also do not expect that noise from transiting project vessels would result in effects on the PBF of the critical habitat that could be meaningfully measured or detected. We therefore conclude that the effects of the proposed project on North Pacific right whale critical habitat, including the planktonic prey that comprise the PBF of this critical habitat, are insignificant (small fuel spills, vessel traffic noise) and discountable (large fuel spills, non-fuel hazardous chemical spills).

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. The potential effects of project vessels transiting between Dutch Harbor and the North Slope on Steller sea lion critical habitat include exposure to spilled or otherwise-discharged fuels or other chemicals, and acoustic or visual disturbance. We evaluate these effects on each of the PBFs of the critical habitat below.

Project activities are not located in a terrestrial zone that is 3,000 ft (0.9 km) landward from a major haulout or rookery, and any effects are extremely unlikely to occur in those areas. Therefore, effects to the terrestrial zones are discountable.

2. *Air zones that extend 3,000 feet (0.9 km) above the terrestrial zone of each major haulout and major rookery in Alaska.*

   Project activities are not located in an air zone that is 3,000 ft (0.9 km) above a major haulout or rookery, and any effects are extremely unlikely to occur in those areas. Therefore, effects to the air zones are discountable.

3. *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.*

   A small portion of the proposed marine transit route overlaps with or is adjacent to parts of the 20-nm aquatic zones in the Bering Sea, including near Dutch Harbor (Figure 6). In addition, depending on the routes vessels take to transit through the Bering Strait, they may also overlap with critical habitat designated on the Pribilof Islands, St. Matthew Island, or St. Lawrence Island.

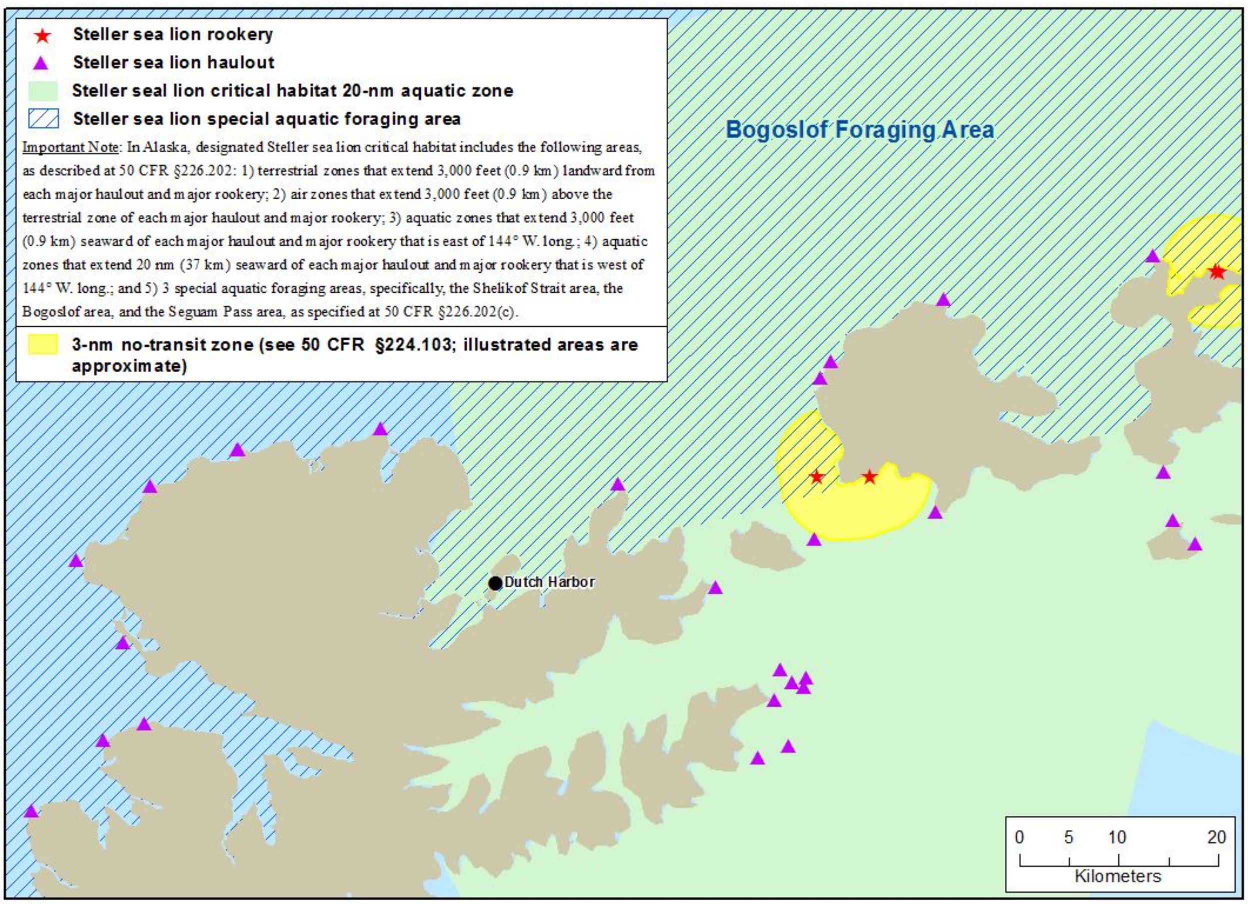
   Waters near Unalaska and Unimak Pass are frequently used by many ocean-going and commercial fishing vessels. Despite all of the traffic in and around rookery and haulout locations near Dutch Harbor, the Steller sea lion population in and around Dutch Harbor has been increasing at about 3% per year (Fritz 2012a).

   The incremental increase in vessel traffic due to this action will be extremely small. Transiting project vessels will be present within or adjacent to the aquatic zones for a very short period of time (about 3 hours), and they will most likely travel only along the outermost edges of these zones. Additionally, project vessels will not travel within 3 nm (5.5 km) of all Steller sea lion rookery or major haulout (see 50 CFR 224.103(c)). Given the minimum distance to be maintained from these sites, as well as the limited overlap of the marine transit route with the aquatic zones, we find it extremely unlikely that the proposed vessel traffic will cause visual or acoustic disturbance to Steller sea lion rookeries or major haulouts. We also consider the probability of a spill or other discharge occurring that would have more than a de minimus effect on the aquatic zones to be very small. Moreover, if a small fuel spill occurred in these waters, within 24 hours it would be expected to evaporate, dissipate, or become entrained. For these reasons, we conclude that the proposed project will have insignificant and discountable effects on this PBF.

4. *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).*

   Dutch Harbor is located within the Bogoslof special aquatic foraging area; consequently, transiting project vessels will travel through this designated area (Figure 14). Waters within the Bogoslof foraging area are frequently used by many ocean-going and commercial fishing vessels. As discussed above, the incremental increase in vessel traffic due to this action will be extremely small (as there will only be a maximum of two vessels per year for certain years of the project). Project vessels will be present within the Bogoslof foraging area for about 20 hours per traverse.

Transiting project vessels are not expected to have adverse impacts on Steller sea lion prey that occur in this foraging zone. For the reasons discussed above with respect to the 20-nm aquatic zones, the small number of vessels transiting through the Bogoslof foraging area are also not expected to have other adverse impacts upon these waters. Therefore we conclude that the proposed project will have insignificant and discountable effects on this PBF.



***Projection:** Alaska Albers Equal Area Conic;* ***Map date:** April 3, 2018;* ***Project file name:** 20180403_Liberty_SSL*

Figure 14. Designated Steller sea lion critical habitat and known Steller sea lion rookeries and haulouts near Dutch Harbor.

In summary, we concur that the proposed action is not likely to adversely affect designated critical habitat for the North Pacific right whale or the Steller sea lion.

Climate Change

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

There is widespread consensus within the scientific community that atmospheric temperatures are increasing and that this will continue for at least the next several decades (Watson and Albritton 2001, Oreskes 2004). There is also consensus within the scientific community that this warming trend will alter current weather patterns and patterns associated with climatic phenomena, including the timing and intensity of extreme events such as heat waves, floods, storms, and wet-dry cycles. Warming of the climate system is unequivocal, as is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (Pachauri and Reisinger 2007).

The Intergovernmental Panel on Climate Change (IPCC) estimated that since the mid-1800s, average global land and sea surface temperature has increased by 0.6°C (±0.2°C), with most of the change occurring since 1976. This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley 2000). The IPCC reviewed computer simulations of the effect of greenhouse gas emissions on climate variations recorded in the past and evaluated the influence of natural phenomena such as solar and volcanic activity. Based on its review, the IPCC concluded that natural phenomena are insufficient to explain the increasing trend in land and sea surface temperature, and that most of the warming observed over the last 50 years, including substantial warming in the Arctic, is likely to be attributable to human activities (Stocker et al. 2013). In addition, anthropogenic forcings are very likely to have contributed to Arctic sea ice loss since 1979 (Stocker et al. 2013).

Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century (Watson and Albritton 2001).

The average annual surface air temperature anomaly over land north of 60°N latitude in October 2016 through September 2017 was the second highest (after 2015 and 2016) in the observational record, which begins in 1900 (Overland et al. 2017). The average global surface temperature rose by 0.85ºC from 1880 to 2012, and it continues to rise at an accelerating pace (IPCC 2014); the 15 warmest years on record since 1880 have occurred in the 21st century, with 2015 being the warmest (NCEI 2016). The warmest year on record for average ocean temperature was also 2015 (NCEI 2016). Since 2000, the Arctic (latitudes between 60ºN and 90ºN) has been warming at more than twice the rate of lower latitudes because of "Arctic amplification," a characteristic of the global climate system influenced by changes in sea ice extent, atmospheric and oceanic heat transports, cloud cover, black carbon, and many other factors (Serreze and Barry 2011, Overland et al. 2017).

In the first decade of the 21st century, Arctic sea ice thickness and annual minimum sea ice extent (i.e., September sea ice extent) declined at a considerably accelerated rate, and approximately three-quarters of summer Arctic sea ice volume has been lost since the 1980s (IPCC 2013) (Figure 15). From 1981 through 2012, the annual minimum extent of perennial and multi-year ice declined by 12 percent and 15 percent, respectively (Comiso 2012). The minimum ice extent reached a record low in 2007 and 2012, when it was 37 percent and 49 percent lower than in the earlier 1979 to 2000 reference period, respectively. Wang and Overland (2009) estimated that the Arctic will be nearly ice-free (i.e., sea ice extent will be less than 1 million square kilometers[km^2]) during the summer between the years 2021 to 2043.

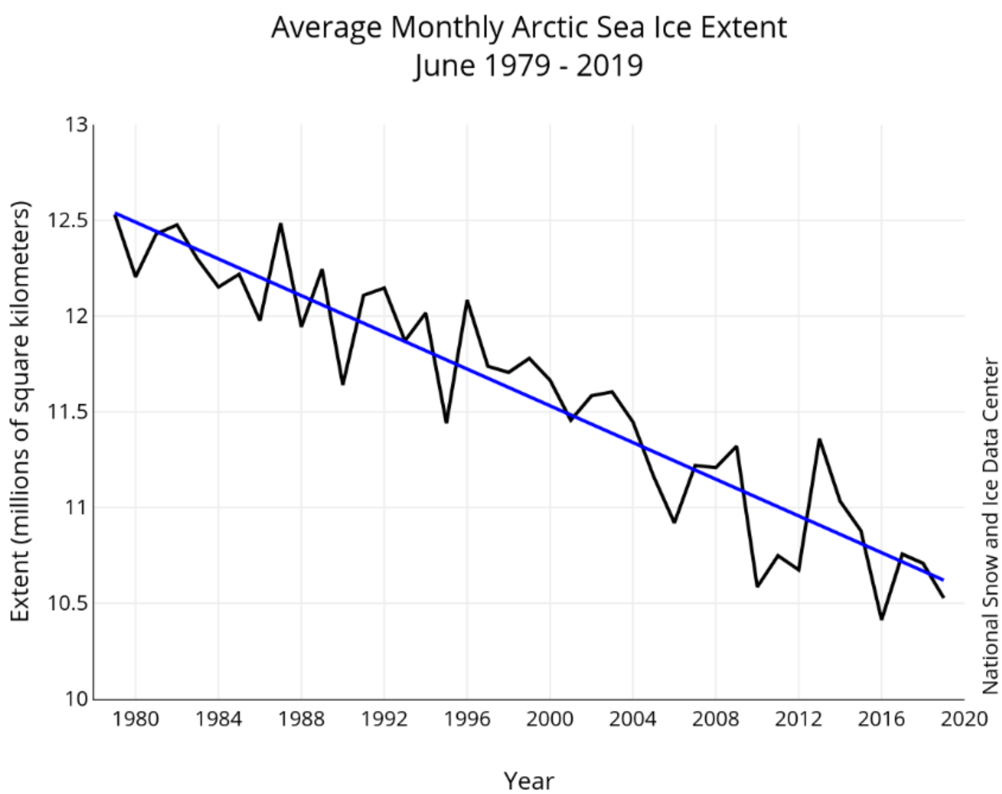


Figure 15. Monthly June ice extent for 1979 to 2019 shows a decline of 4.08 percent per decade (National Snow and Ice Data Center, https://nsidc.org/arcticseaicenews/; accessed July 8, 2019).

The National Snow and Ice Data Center (NSIDC) reported that the Arctic sea ice extent for March 2018 averaged 14.30 million km^2 (5.52 million square miles [mi^2]), the second lowest in the 1979 to 2018 satellite record. This was 1.13 million km^2 (436,300 mi^2) below the 1981 to 2010 average and 30,000 km^2 (11,600 mi^2) above the record low March extent in 2017. Sea ice extent at the end of March 2018 was far below average in the Bering Sea, as it was in the previous several months, and was slightly below average in the far northern Atlantic Ocean and Barents Sea (NSIDC 2018).

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 2001, Parry 2007). Effects of climate change on physical aspects of the marine environment include, among others, increases in atmospheric temperatures; decreases in sea ice; and changes in sea surface temperatures, oceanic pH, patterns of precipitation, and sea level. Such changes have impacted, are impacting, and will continue to impact marine species in a variety of ways, such as (IPCC 2014):

- Shifting abundances
- Changes in distribution
- Changes in timing of migration
- Changes in periodic life cycles of species

Thinning and reduced coverage of Arctic sea ice are likely to substantially alter ecosystems that are in close association with sea ice (Loeng et al. 2005). For example, variations in the recruitment of krill (*Euphausia superba*) and the reproductive success of krill predators has been linked to variations in sea-surface temperatures and the extent of sea-ice cover during the winter months.

Climate change is likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2009). Therefore, we expect the extinction risk of at least some ESA-listed species to rise with global warming. Cetaceans with restricted distributions linked to water temperature may be particularly exposed to range restriction (Learmonth et al. 2006, Isaac 2009). Macleod (2009) estimated that, based on expected shifts in water temperature, 88 percent of cetaceans will be affected by climate change, 47 percent will be negatively affected, and 21 percent will be put at risk of extinction. Of greatest concern are cetaceans with ranges limited to non-tropical waters, and preferences for shelf habitats (Macleod 2009).

Bowhead whales are dependent on sea-ice organisms for feeding and polynyas for breathing, so the early melting of sea ice may lead to an increasing mismatch in the timing of these sea-ice organisms and secondary production (Loeng et al. 2005). However, George et al. (2006) showed that landed bowheads had better body condition during years of light ice cover. Shelden et al. (2003) noted that there is a high probability that bowhead abundance will increase under a warming global climate (see Section 5.9 for additional information).

The depth and duration of snow cover are projected to decline substantially throughout the range of the Arctic ringed seal, reducing the areas with suitable snow depths for their lairs by an estimated 70 percent by the end of this century (Hezel et al. 2012). The persistence of this species will likely be challenged as decreases in ice and, especially, snow cover lead to increased juvenile mortality from premature weaning, hypothermia, and predation (Cameron et al. 2010, Kelly et al. 2010). It is likely that, within the foreseeable future, the number of ringed seals will decline substantially, and they will no longer persist in substantial portions of their range (Cameron et al. 2010, Kelly et al. 2010). The persistence of Beringia DPS bearded seals will likely be challenged as reduction in the timing and extent of sea ice lead to spatial separation of sea ice from shallow feeding areas and decreases in ice suitable for molting and pup maturation, which will likely compromise their reproductive and survival rates (Cameron et al. 2010).

Status of Listed Species

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02.

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 for Alaska marine mammals (Muto et al. 2017) and the comprehensive status review reports completed in 2010 for bearded and ringed seals (Cameron et al. 2010, Kelly et al. 2010). ASAMM surveys provide information on bowhead whale distribution.

4.1.3 Bowhead Whale

Status and Population Structure

The International Whaling Commission (IWC) recognizes four stocks of bowhead whale for management purposes. The Western Arctic stock (also known as the Bering-Chukchi-Beaufort stock) is the largest and only stock found in U.S. waters and the action area (Muto et al. 2017).

The bowhead whale was listed as endangered under the Endangered Species Conservation Act (ESCA) of 1969 on December 2, 1970 (35 FR 18319). Congress replaced the ESCA with the ESA in 1973, and bowhead whales continued to be listed as endangered. Critical habitat has not been designated for bowhead whales. The bowhead whale became endangered because of past commercial whaling. The IWC prohibited commercial whaling, and called for a ban on subsistence whaling in 1977. The United States requested a modification of the ban, and the IWC responded with a limited quota.

Woodby and Botkin (1993) summarized previous efforts to determine a minimum worldwide population estimate prior to commercial whaling and reported a minimum pre-exploration estimate for all stocks of 50,000 whales, with 10,400 to 23,000 in the Western Arctic stock (dropping to less than 3,000 at the end of commercial whaling). Subsequently, Brandon and Wade (2006) used Bayesian model averaging to estimate that the Western Arctic stock consisted of 10,960 (9,190 to 13,950; 5th and 9th percentiles, respectively) bowheads in 1848 at the start of commercial whaling (Muto et al. 2017).

Givens et al. (2013) estimate that, from 1978 to 2011, the Western Arctic stock of bowhead whales increased at a rate of 3.7 percent (95 percent confidence interval of 2.8 to 4.7 percent) during which time abundance tripled from approximately 5,000 to approximately 16,000 whales. Similarly, using sight-resight analysis of aerial photographs, Schweder et al. (2010) estimated the yearly growth rate of this stock between 1984 and 2003 to be 3.2 percent. Based on corrected counts of bowhead whales by ice-based observers in 2001, the abundance of the Western Arctic stock was estimated to be 10,545 individuals (coefficient of variation, 0.128) (updated from (George et al. 2004) by (Zeh and Punt 2005)). Ten years later in 2011, the ice-based abundance estimate was 16,892 individuals (95 percent confidence interval, 15,704 to 18,928) (Givens et al. 2013). Using the 2011 population estimate of 16,892 and its associated coefficient of variation of

0.058, the most recent minimum population estimate for the Western Arctic stock of bowhead whales is 16,091 (Muto et al. 2017).

Distribution

Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984, Moore and Reeves 1993). During winter and spring, bowhead whales are closely associated with pack ice or in polynyas (large, semi-stable open areas of water within the ice), and move north as the sea ice breaks up and recedes during the spring. During summer, most of the population is in relatively ice-free waters in the southeastern Beaufort Sea; however, some whales move back and forth between the Alaskan and Canadian Beaufort Sea during the summer feeding season (Quakenbush et al. 2010).

The majority of the Western Arctic stock migrates annually from wintering areas (December to March) in the northern Bering Sea, through the Chukchi Sea in the spring (April through May), to the eastern Beaufort Sea where they spend much of the summer feeding (June through early to mid-October) before returning again to the Bering Sea in the fall (September through December) to overwinter (Figure 15; Muto et al. 2017).

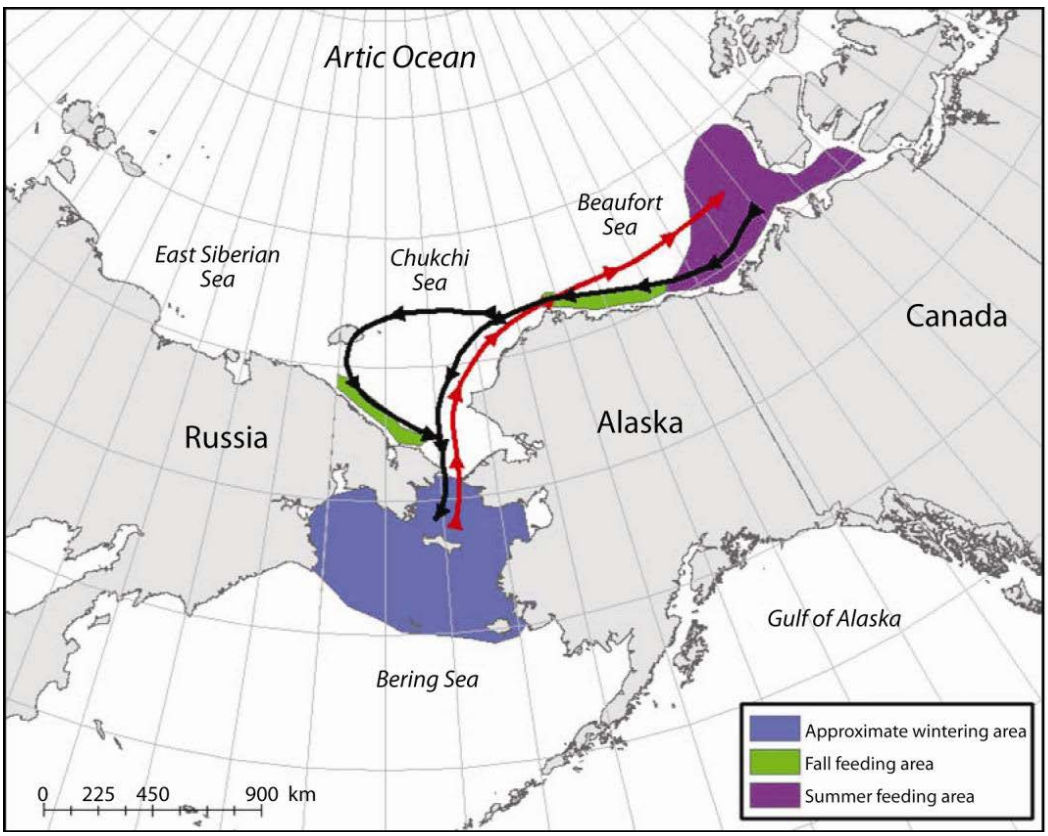


Figure 16. Generalized migration route, feeding areas, and wintering area for Western Arctic bowhead w hale (Moore and Laidre 2006).

Occurrence in the Action Area

The vast majority of the bowhead population migrate to the Bering Sea during the fall and do not return eastwards through the Beaufort Sea again until the spring. During the eastward (spring) migration, the whales are distributed far offshore. While a few whales may occur in the Central Beaufort Sea area throughout the summer, most of the population spend the summer in the eastern Beaufort Sea before passing through again during the latter part of summer and fall as bowheads migrate west to over winter in the Bering Sea. Bowhead whales are most likely to be encountered during the fall migration when bowhead whales travel closer to shore (than during the spring migration) in water ranging from 15 to 200 m deep (50 to 656 ft; Miller et al. 2002, Clarke et al. 2012). The fall migration trajectory varies annually and is influenced by ice presence (Moore and Reeves 1993); during years with less ice the whales tend to migrate closer to shore, along the barrier islands. Bowhead whale sightings during the fall migration are also lower in heavy ice years. Treacy et al. (2006) found that the main migration corridor for bowhead whales during the fall migration was 73.4 km (46 mi) offshore in years of heavy ice conditions, 49.3 km (31 mi) offshore during moderate ice conditions, and 31.2 km (19 mi) off shore during light ice conditions.

Clarke et al. (2015) evaluated biologically important areas (BIAs) for bowheads in the U.S. Arctic region and identified nine BIAs. The spring (April-May) migratory corridor BIA for bowheads is far offshore of the LDPI but within the transit portion of the action area, while the fall (September-October) migratory corridor BIA (western Beaufort on and north of the shelf) for bowheads is further inshore and closer to the LDPI and within the transit, noise, and spill portions of the action area. Clarke et al. (2015) also identified four BIAs for bowheads that are important for reproduction and encompassed areas where the majority of bowhead whales identified as calves were observed each season; none of these reproductive BIAs overlap with the LDPI, but may be encompassed in the transit, noise, and spill portions of the action area. Finally, three bowhead feeding BIAs were identified. Only the September-October feeding BIA (bowheads feeding on the western Beaufort continental shelf, out to approximately the 50-m isobaths) came close to the LDPI but did not overlap. However, the fall feeding BIA may overlap with potential transit, noise, or spill portions of the action area.

Satellite tracking studies since 2006 indicate that bowhead whales were generally present in the Alaskan Beaufort Sea between April and October (Figure 17 through Figure 23). Locations within a specific localized area that showed a “zig-zag” movement pattern were classified as associated with lingering behavior (inferred feeding; Quakenbush 2018). In April and May, whales migrated east past the proposed LDPI site in route to Amundsen Gulf and the Cape Bathurst Polynya (Figure 17 and Figure 18). At this time, whales were typically north of the shelf break, which is approximately 70 km (43 mi) north of the proposed LDPI site (Quakenbush 2018). Some whales return to the Alaskan Beaufort Sea in June and July (Figure 19 and Figure 20), prior to the main migration in September and October. Many (but not all) of these movements also occurred north of the shelf break.

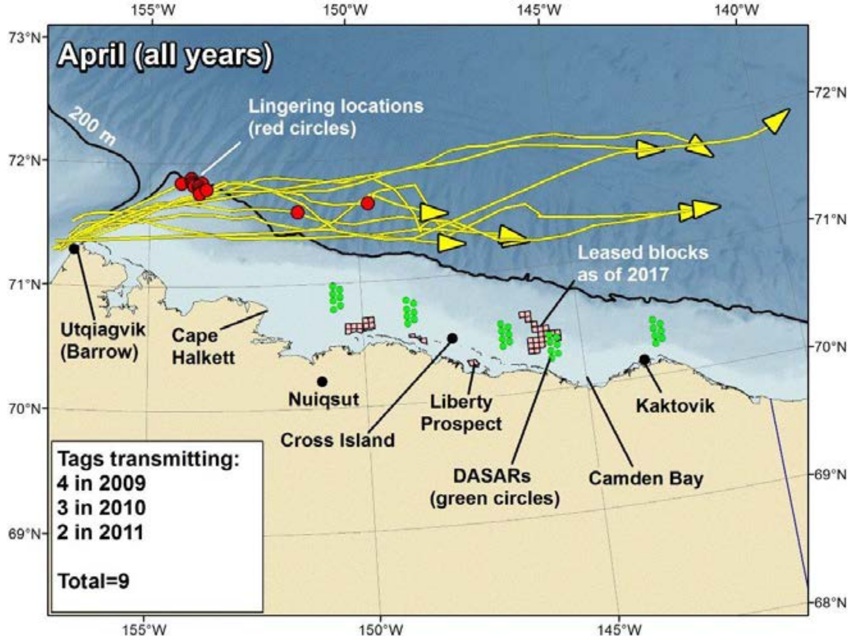


Figure 17. Tracks of satellite tagged bowhead whales during April near the Liberty Project (Quakenbush 2018).

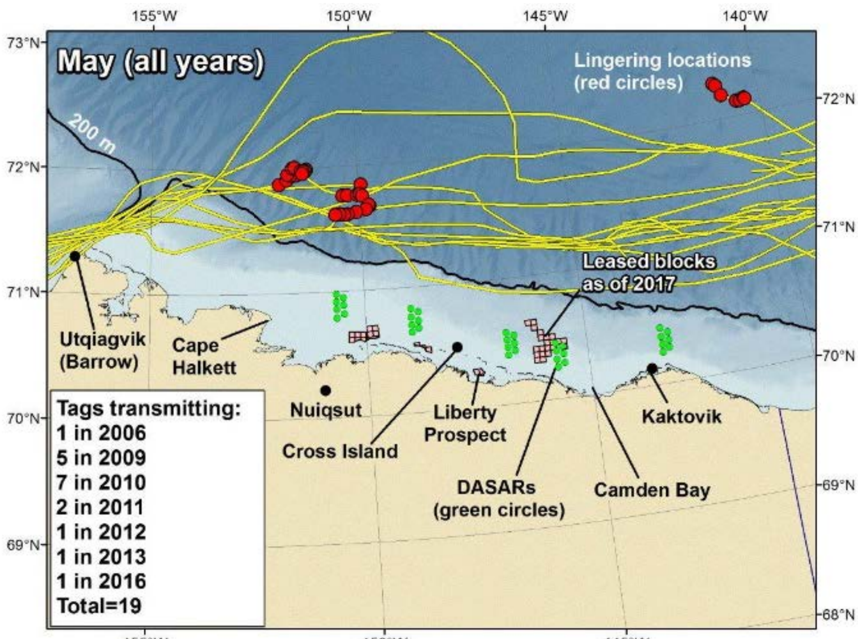


Figure 18. Tracks of satellite tagged bowhead whales during May near the Liberty Project (Quakenbush 2018).

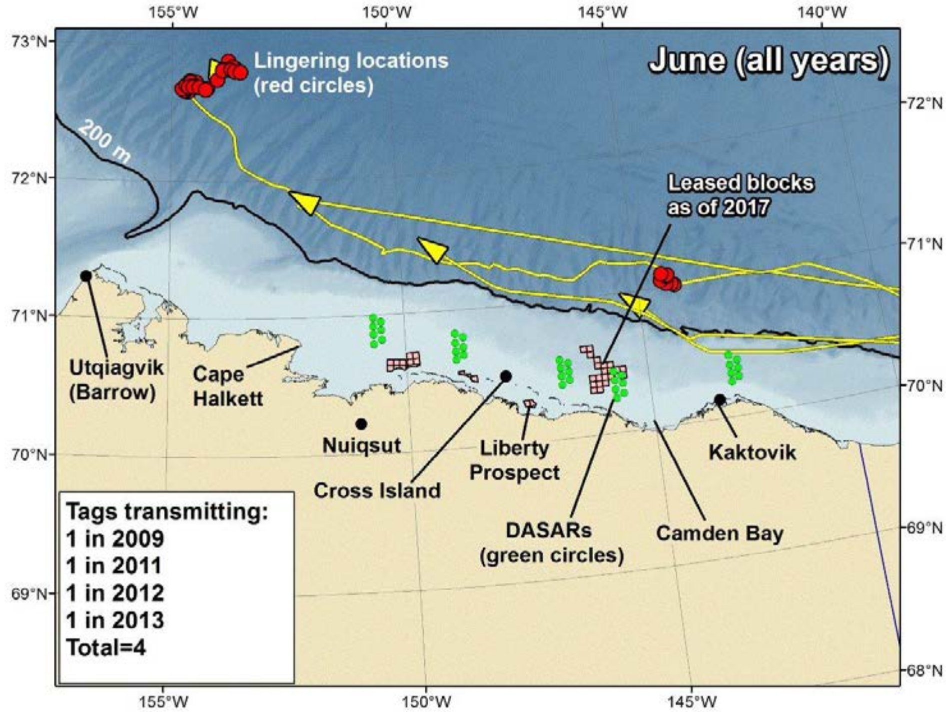


Figure 19. Tracks of satellite tagged bowhead whales during June near the Liberty Project (Quakenbush 2018).

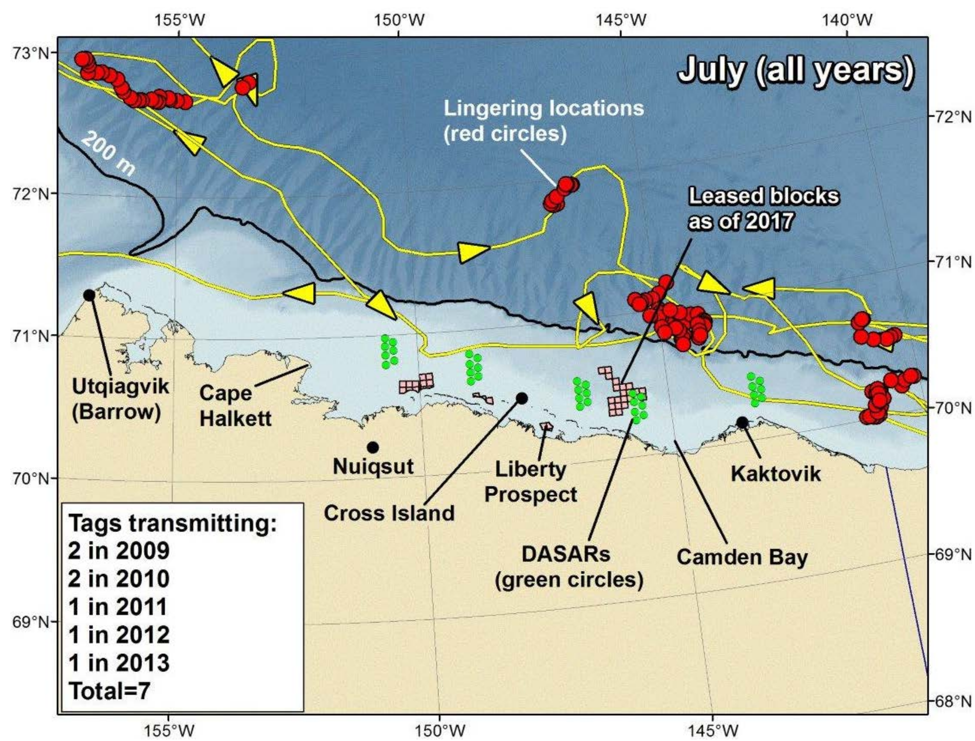


Figure 20. Tracks of satellite tagged bowhead whales during July near the Liberty Project (Quakenbush 2018).

Tagged whales first began making inshore movements in August (Figure 21). A whale passed within 16 km (10 mi) of the proposed LDPI site in August of 2016. Movements of tagged bowhead whales tended to be outside of the barrier islands in September and October (Figure 22 and Figure 23). Although tagged whales may have migrated inshore of the barrier islands (between successful satellite uplinks), the large majority of movements appeared to be outside the barrier islands. The main migratory corridor for tagged whales extended approximately 40 km (25 mi) north from the barrier islands, which are located approximately 7 km (4 mi) north of Liberty Project (Quakenbush 2018).

Quakenbush (2018) did not identify lingering locations (inferred feeding locations) for tagged whales that were closer than 30 km (19 mi) from the LDPI. One whale paused its migration in September of 2010 for a single 6-hour interval, approximately 30 km (19 mi) east-northeast of the LDPI. This does not mean that whales may not sometimes feed closer to the LDPI. However, the main feeding area in the Alaskan Beaufort Sea is west of Cape Halkett (approximately 180 km [112 mi] west of the LDPI). Tagged bowhead data also showed limited feeding behavior in Camden Bay (approximately 100 km [62 mi] east of the LDPI), where one whale lingered for four days and another lingered for nine days in 2010 (Quakenbush 2018). Migrating (i.e. non-feeding) bowhead whales spent an average of 2 days in the Prudhoe Bay area (Quakenbush et al. 2013). There have been no locations of tagged bowhead whales east of Cape Halkett later than October. Although movements of tagged animals do not likely represent movements of the entire population they do indicate that bowhead whales are in the LDPI action area in summer and fall (Quakenbush 2018).

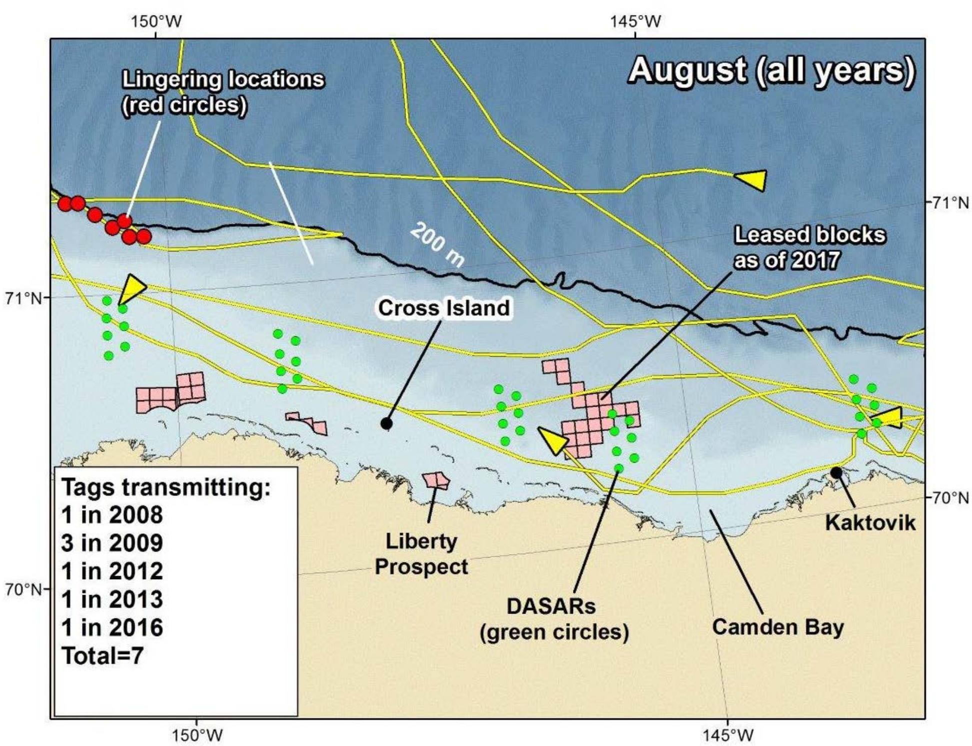


Figure 21. Tracks of satellite tagged bowhead whales during August near the Liberty Project (Quakenbush 2018).

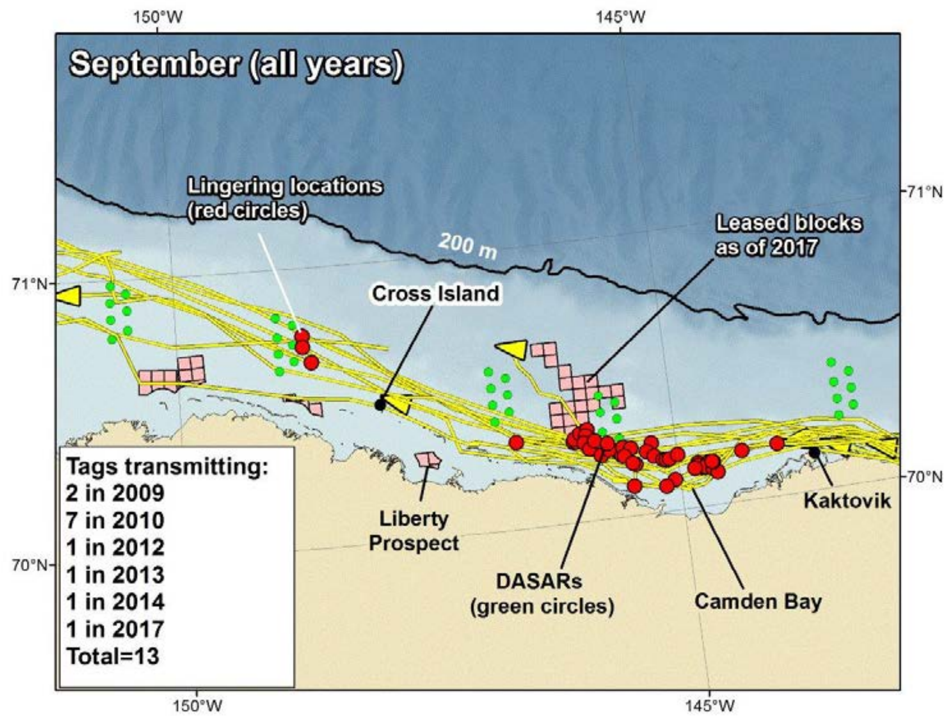


Figure 22. Tracks of satellite tagged bowhead whales during September near the Liberty Project (Quakenbush 2018).

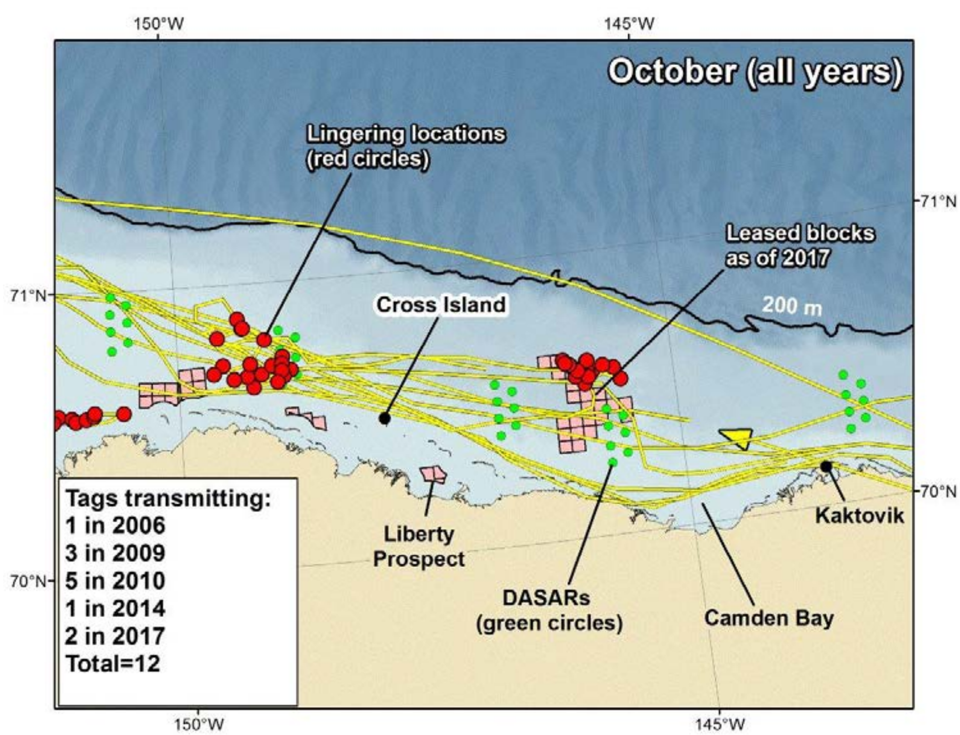


Figure 23. Tracks of satellite tagged bowhead whales during October near the Liberty Project (Quakenbush 2018).

During summer seismic surveys conducted in Foggy Island Bay in 2008, only one cetacean sighting was documented by Protected Species Observers (PSO) shoreward of the barrier islands. This sighting was of a mixed group of eight bowhead and gray whales southwest of Narwhal Island (Aerts et al. 2008). However, no bowhead whales were observed by PSO during recent shallow hazards surveys conducted in Foggy Island Bay (Smultea et al. 2014, Cate et al. 2015). From 2001 through 2004, 95 percent of bowhead whales detected during fall acoustic monitoring at Northstar were located 8.4 to 14.2 km (8.4 to 22.8 mi) offshore beyond the barrier islands (Blackwell et al. 2007).

The ASAMM project is a continuation of the Bowhead Whale Aerial Survey Project (BWASP) and Chukchi Offshore Monitoring in Drilling Area (COMIDA) marine mammal aerial survey project. Through these projects aerial surveys have been conducted in the Alaska Beaufort Sea in late summer and autumn since 1979 (Ljungblad et al. 1986, Ljungblad et al. 1987, Monnett and Treacy 2005, Treacy et al. 2006, Clarke et al. 2012, 2013a, Clarke et al. 2013b). Before 2016, the ASAMM study area did not include waters inside the barrier islands near the LDPI. Figure 24 displays sightings of bowhead whales near the Liberty Project since 2009. The ASAMM database and annual reports are available from the NMFS Marine Mammal Laboratory (MML) web page: http://www.afsc.noaa.gov/NMML/cetacean/.

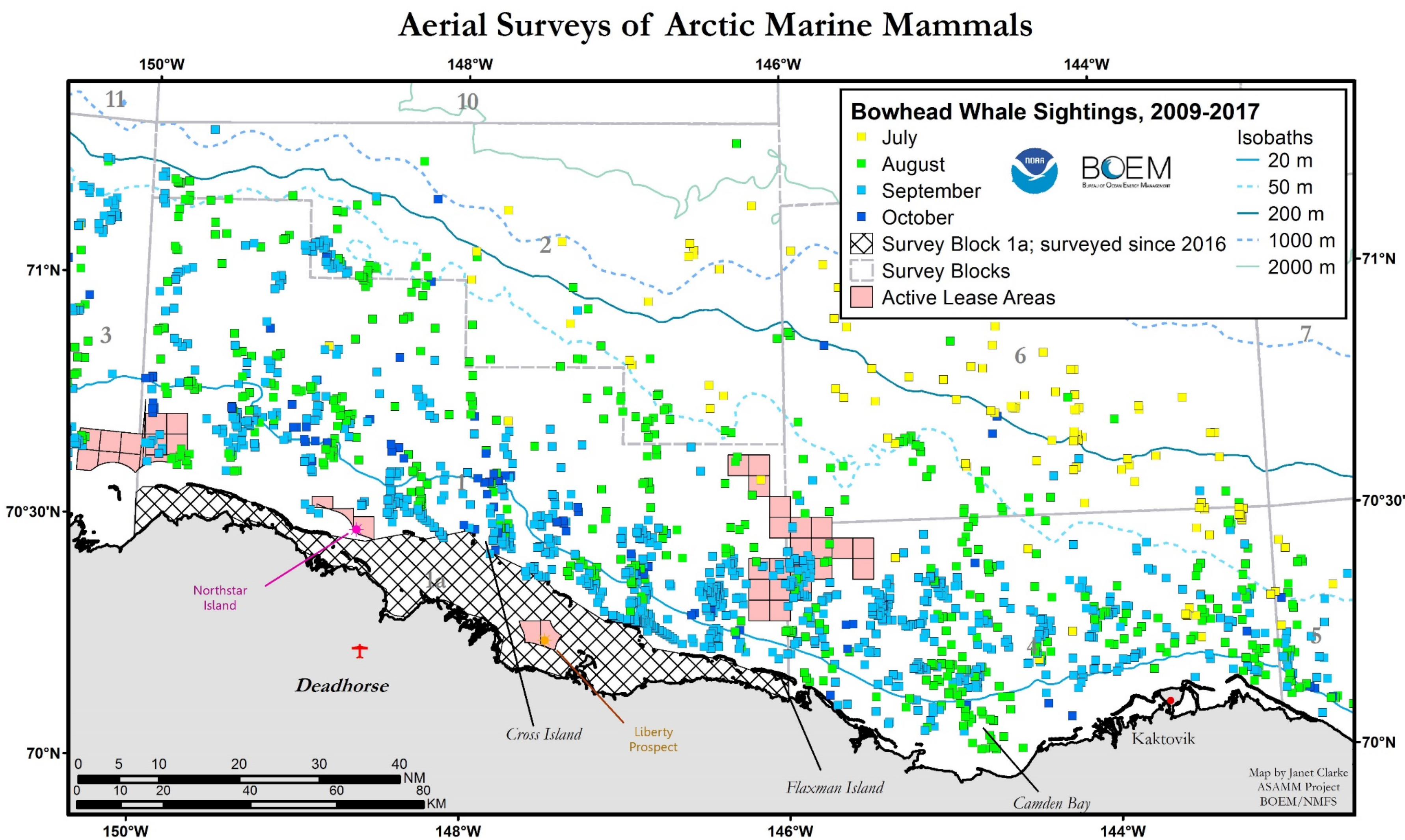


Figure 24. ASAMM bowhead whale sightings, 2009 – 2017 (Clarke 2018).

As mentioned, during the ice-covered season (winter and spring) bowhead whales will not be present at or near the LDPI. Summer and fall bowhead whale densities were calculated using the results from ASAMM surveys from 2011 through 2015. The surveys provided sightings and effort data by month and season (summer and fall), as well as each survey block (Clarke et al. 2012, 2013a, Clarke et al. 2014, Clarke et al. 2015, Clarke et al. 2017). While none of the effort and sighting data reported in the aerial survey reports from surveys conducted in 2011 through 2015 included the Liberty Project site within Foggy Island Bay due to its more inshore location within the barrier islands, we followed the approach used in previous Liberty IHA applications and selected only on-transect effort and sighting data from Survey Block 1 of the ASAMM survey.

Bowhead whale densities were calculated in a two-step approach; first (SMRU Consulting 2017) calculated a sighting rate of whales per km, then they multiplied the transect length by the effective strip width using the modeled species-specific effective strip width for an aero commander aircraft calculated by Ferguson and Clarke (2013). Where the effective strip width is the half-strip width it must be multiplied by 2 in order to encompass both sides of the transect line. Thus whale density was calculated as follows:

$$\text{Whales per km}^2 = \text{sightings per kilometer} / (2 \text{ x the effective strip width})$$

The effective strip width for bowhead whales was calculated to be 1.15 km (CV = 0.08). This resulted in a mean density estimate for survey Block 1 in summer of 0.005 bowhead whales/km2 (range = 0.001-0.006), and a mean fall density for survey Block 1 of 0.010 bowhead whales/km2 (range = 0.004-0.022; Table 8). These density estimates are expected to be overestimates for the LDPI action area as bowhead whales rarely occur within the barrier islands, instead preferring to migrate north of the barrier islands.

Table 8. ASAMM survey results for bowhead whales from 2011-2017 (SMRU Consulting 2017).

Year	Dates	On Transect Effort (km)	On Transect Sightings	Whales/km	Whales/km^2
2011					
Summer	June – Aug	346	1	0.003	0.001
Fall	Sept – Oct	1,476	24	0.016	0.007
2012					
Summer	19 Jul – 31 Aug	1,493	5	0.003	0.001
Fall	1 Sep – 18 Oct	1,086	14	0.013	0.006
2013					
Summer	Jul – Aug	1,582	21	0.013	0.006
Fall	Sept – Oct	1,121	21	0.019	0.008
2014					
Summer	Jul – Aug	1,393	17	0.012	0.005
Fall	Sept – Oct	1,538	79	0.051	0.022
2015					
Summer	Jul – Aug	1,262	15	0.012	0.005
Fall	Sept – Oct	1,663	17	0.010	0.004
2016					
Summer	Jul – Aug	1,914	74	0.039	0.017
Fall	Sept – Oct	2,360	19	0.008	0.004
2017					
Summer	Jul – Aug	3,003	8	0.003	0.001
Fall	Sept – Oct	1,803	85	0.047	0.020
				Average Summer	0.005[1]
				Summer Range	(0.001 – 0.017)
				Average Fall	0.010[1]
				Fall Range	(0.004 – 0.022)

[1]Value represents average, not total, across all years per relevant season

Source: (Clarke et al. 2013a, Ferguson and Clarke 2013, Clarke et al. 2014, Clarke et al. 2015)

Note: The previous opinion (issued in July 2018) and SMRU Consulting 2017 report contained slightly different numbers for 2011 and 2012 fall densities. For 2011 and 2012, there was a minor error in total on transect effort, which results in changes in whales/km and whales/km^2.

Feeding and Prey Selection

Evidence suggests that bowhead whales feed on concentrations of zooplankton throughout their range (Muto et al. 2017). Bowheads are filter feeders, straining prey from the water through baleen (Lowry 1993). They feed throughout the water column, including bottom feeding as well as skim feeding near the surface (Würsig et al. 1989). Skim feeding can occur when animals are alone or may occur in coordinated echelon formations of over a dozen animals (Würsig et al. 1989). Bowhead whales typically spend a high proportion of time on or near the ocean floor. Even when traveling, bowhead whales visit the bottom on a regular basis (Quakenbush et al. 2010). Laidre et al. (2007) and others have identified krill concentrated near the sea bottom, and bowhead whales have been observed with mud on their heads and bodies and streaming from their mouths (Mocklin 2009). Food items most commonly found in the stomachs of harvested bowheads include euphausiids, copepods, mysids, and amphipods (Lowry et al. 2004, Moore et al. 2010). Euphausiids and copepods are thought to be their primary prey. Lowry et al. (2004) documented that other crustaceans and fish also were eaten but were minor components in samples consisting mostly of copepods or euphausiids.

Concentrations of zooplankton appear necessary for bowhead whales and other baleen whales to feed efficiently to meet energy requirements (Kenney et al. 1986, Lowry 1993). It is estimated that a 60 ton bowhead whale eats 1.5 ton of krill each day. Estimated rate of consumption is 50,000 individual copepods, each weighing about 0.004 g, per minute of feeding time (BOEM 2011).

Western Arctic bowhead whales feed in the outer continental shelf of the Chukchi and Beaufort Seas with level of use varying among years, among individuals, and among areas. It is likely that bowheads feed opportunistically where food is available as they move through or about the Alaskan Beaufort Sea.

Hearing, Vocalizations, and Other Sensory Abilities

Bowhead whales are among the more vocal of the baleen whales (Clark and Johnson 1984). Most underwater calls are at a fairly low frequency and easily audible to the human ear. Vocalization is made up of moans of varying pitch, intensity and duration, and occasionally higher-frequency screeches. Bowhead whale songs have a bandwidth of 20 to 5000 Hz with the dominant frequency at approximately 500 Hz and duration lasting from 1 minute to hours. Pulsive vocalizations range between 25 and 3,500 Hz and lasts 0.3 to 7.2 seconds (Clark and Johnson 1984, Wursig and Clark 1993, Erbe 2002a).

NMFS categorizes bowhead whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group, with an estimated hearing range of 7 Hz to 35 kHz (NMFS 2018b). Inferring from their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz and 5 kHz, with maximum sensitivity between 100 Hz and 500 Hz (Erbe 2002a).

Bowhead whales have well-developed capabilities for navigation and survival in sea ice. Bowhead whales are thought to use the reverberations of their calls off the undersides of ice floes to help them orient and navigate (Ellison et al. 1987, George et al. 1989). This species is well adapted to ice-covered waters and can easily move through extensive areas of nearly solid sea ice cover (Citta et al. 2012). Their skull morphology allows them to break through ice up to 18 cm thick to breathe in ice covered waters (George et al. 1989).

Bowhead whales appear to have good lateral vision. Recognizing this, whalers approach bowheads from the front or from behind, rather than from the side (Rexford 1997). In addition, whalers wear white parkas on the ice so that they are not visible to the whales when they surface (Rexford 1997, Noongwook et al. 2007).

Olfaction may also be important to bowhead whales. Recent research on the olfactory bulb and olfactory receptor genes suggests that bowheads not only have a sense of smell but one better developed than in humans (Thewissen et al. 2011). The authors speculated that bowheads may use their sense of smell to find dense aggregations of krill upon which to prey.

4.1.4 Arctic Ringed Seal

Status and Population Structure

Under the MMPA, NMFS recognizes one stock of Arctic ringed seals, the Alaska stock, in U.S. waters (and the action area). The Arctic ringed seal was listed as threatened under the ESA on December 28, 2012, primarily due to expected impacts on the population from declines in sea and snow cover stemming from climate change within the foreseeable future (77 FR 76706).

Ringed seal population surveys in Alaska have used various methods and assumptions, incompletely covered their habitats and range, and were conducted more than a decade ago; therefore, current and comprehensive abundance estimates or trends for the Alaska stock are not available. Frost et al. (2004) conducted aerial surveys within 40 km (25 mi) of shore in the Alaska Beaufort Sea during May and June from 1996 through 1999 and observed ringed seal densities ranging from 0.81 seals per square kilometer in 1996 to 1.17 seals per square kilometer in 1999. Moulton et al. (2002b) conducted similar, concurrent surveys in the Alaska Beaufort Sea between 1997 and 1999 but reported substantially lower ringed seal densities than Frost et al. (2004). The reason for this disparity was unclear (Frost et al. 2004). Bengtson et al. (2005) conducted aerial surveys in the Alaska Chukchi Sea during May and June of 1999 and 2000. While the surveys were focused on the coastal zone within 37 km (23 mi) of shore, additional survey lines were flown up to 185 km (115 mi) offshore. Population estimates were derived from observed densities corrected for availability bias using a haul-out model from six tagged seals. Ringed seal abundance estimates for the entire survey area were 252,488 (standard error = 47,204) in 1999 and 208,857 (standard error = 25,502) in 2000. Using the most recent survey estimates from surveys by Bengtson et al. (2005) and Frost et al. (2004) in the late 1990s and 2000, Kelly et al. (2010) estimated the total population in the Alaska Chukchi and Beaufort seas to be at least 300,000 ringed seals. This estimate is likely an underestimate since the Beaufort Sea surveys were limited to within 40 km from shore.

Though a reliable population estimate for the entire Alaska stock is not available, research programs have recently developed new survey methods and partial, but useful, abundance estimates. In spring of 2012 and 2013, U.S. and Russian researchers conducted image-based aerial abundance and distribution surveys of the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). The data from these surveys are still being analyzed, but for the U.S. portion of the Bering Sea, Boveng et al. (2017) reported model-averaged abundance estimates of 186,000 and 119,000 ringed seals in 2012 and 2013, respectively. It was noted that these estimates should be viewed with caution because a single point estimate of availability (haul-out correction factor) was used and the estimates did not include ringed seals in the shorefast ice zone, which was surveyed using a different method. The authors suggested that the difference in seal density between years may reflect differences in the numbers of ringed seals using Russian versus U.S. waters between years, and they noted that if this was the case, the eventual development of comprehensive estimates of abundance for ringed seals in the Bering Sea that incorporate data in Russian waters may show less difference between years.

Distribution

Arctic ringed seals have a circumpolar distribution and are found throughout the Arctic basin and in adjacent seasonally ice-covered seas. They remain with the ice most of the year and use it as a haul-out platform for resting, pupping, and nursing in late winter to early spring, and molting in late spring to early summer. During summer, ringed seals range hundreds to thousands of kilometers to forage along ice edges or in highly productive open-water areas (Harwood and Stirling 1992, Freitas et al. 2008, Kelly et al. 2010, Harwood et al. 2015). Harwood and Stirling (1992) reported that in late summer and early fall, aggregations of ringed seals in open-water in some parts of their study area in the southeastern Canadian Beaufort Sea where primary productivity was thought to be high. (Harwood et al. 2015) also found that in the fall, several satellite-tagged ringed seals showed localized movements offshore east of Point Barrow in an area where bowhead whales are known to concentrate in the fall to feed on zooplankton. With the onset of freeze-up in the fall, ringed seal movements become increasingly restricted. Seals that have summered in the Beaufort Sea are thought to move west and south with the advancing ice pack, with many seals dispersing throughout the Chukchi and Bering seas while some remain in the Beaufort Sea (Frost and Lowry 1984, Crawford et al. 2012, Harwood et al. 2012). Some adult ringed seals return to the same small home ranges they occupied during the previous winter (Kelly et al. 2010).

Occurrence in the Action Area

Ringed seals are resident in the Beaufort Sea year-round, and based on results of previous surveys in Foggy Island Bay (Aerts et al. 2008, Funk et al. 2008, Savarese et al. 2010, Smultea et al. 2014), and monitoring from Northstar Island (Aerts and Richardson 2009, 2010), they are expected to be the most commonly occurring pinniped in the action area year-round.

Ringed seals are present in the nearshore Beaufort Sea waters and sea ice year-round, maintaining breathing holes and excavating subnivean lairs in the landfast ice during the ice-covered season. Ringed seals overwinter in the landfast ice in and around the LDPI action area. There is some evidence indicating that ringed seal densities are low in water depths of less than 3 m, where landfast ice extending from the shoreline generally freezes to the sea bottom in very shallow waters during the course of the winter (Moulton et al. 2002a, Moulton et al. 2002b, Richardson and Williams 2003). Ringed seal movements during winter and spring are typically quite limited, especially where ice cover is extensive (Kelly et al. 2010). During April to early June (the reproductive period), radio-tagged ringed seals inhabiting shorefast ice near Prudhoe Bay had home range sizes generally less than 1,336 ac (500 ha) in area (Kelly et al. 2005).

Limited data are available on ringed seal densities in the southern Beaufort Sea during the winter months; however, ringed seals winter ecology studies conducted in the 1980s (Kelly et al. 1986, Frost and Burns 1989) and surveys associated with the Northstar development (Williams et al. 2001) provide information on both seal ice-structure use (where ice structures include both breathing holes and subnivean lairs), and on the density of ice structures (Table 9).

Table 9. Summary of sea-ice structure density from in and around the Liberty Project area (SMRU Consulting 2017).

Year	Ice-structure density/km2	Source
1982	3.6	Frost and Burns 1989
1983	0.81	Kelly et al. 1983
Dec 1999	0.71	Williams et al. 2001
May 2000	1.2	Williams et al. 2001
Average Structure density / km^2	1.58	
Note: The previous opinion (issued in July 2018) and SMRU Consulting 2017 report contained an error for the December 1999 density. The correct density presented here changes the average structure density / km		

Kelly et al. (1986) found that in the southern Beaufort Sea and Kotzebue Sound, radio-tagged seals used between 1 and at least 4 subnivean lairs. The distances between lairs was up to 4 km (10 mi), with numerous breathing holes in-between (Kelly et al. 1986). While Kelly et al. (1986) calculated the average number of lairs used per seal to be 2.85, they also suggested that this was likely to be an underestimate. To estimate winter ringed seal density within the project area, the average ice structure density of 1.58/km^2 (Table 9) was divided by the average number of ice structures used by an individual seal of 2.85 (SD=2.51; Kelly et al. 1986). This results in an estimated density of 0.55 ringed seals/km^2 during the winter months. This density is likely to be overestimated due to Kelly et al. (1986) suggestion that their estimate of the average number of lairs used by a seal was an underestimate (the denominator used).

For spring ringed seal densities, aerial surveys flown in 1997 through 2002 over Foggy Island Bay and west of Prudhoe Bay during late May and early June (Figure 24; Frost et al. 2002, Moulton et al. 2002b, Richardson and Williams 2003), when the greatest percentage of seals have abandoned their lairs and are hauled out on the ice (Kelly et al. 2010), provides the best available information on ringed seal densities.

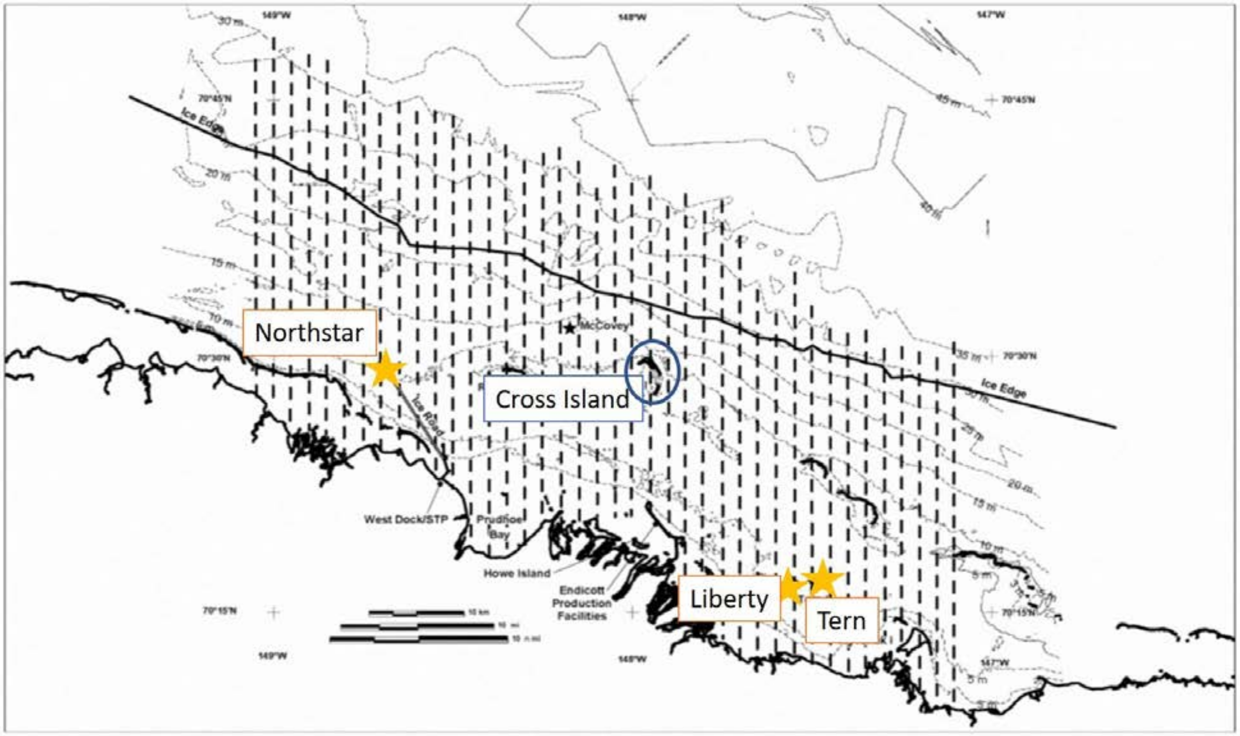


Figure 25. Aerial survey transects flown in May-June 2002. Similar surveys were flown in each year 1997-2001 (Figure taken from Richardson and Williams 2002).

Because densities were consistently very low where water depth was less than 3 m (and these areas are generally frozen solid during the ice-covered season) densities have been calculated where water depth was greater than 3 m deep (Moulton et al. 2002a, Moulton et al. 2002b, Richardson and Williams 2003). Based on the average density of surveys flown 1997 to 2002, the uncorrected density of ringed seals during the spring is expected to be 0.548 ringed seals/km^2. A summary of available density data and the uncorrected densities available for 1997 to 2002 are provided in (Table 10).

Table 10. Estimated ringed seals densities during spring aerial surveys 1997-2002

Year	1997	1998	1999	2000	2001	2002	**Average**
Density (Number of seals/km^2)	0.43	0.39	0.63	0.47	0.54	0.83	0.548
Source: (Moulton et al. 2002a, Moulton et al. 2002b, Richardson and Williams 2003, SMRU Consulting 2017).							

The highest observed density for the Prudhoe Bay and Liberty area was used as the maximum. Because these density estimates were calculated from spring data and the numbers of seals is expected to be much lower during the open water season, the densities used for the proposed action were (conservatively) estimated to be 50 percent of the spring densities (Table 10), this resulted in an estimated density of 0.27 ringed seals/km^2. Ringed seals remain in the water through the fall and in to the winter, however, due to the lack of available data on fall densities within the LDPI action area we have conservatively assumed the same density of ringed seals as in the summer; 0.27 ringed seals/km^2.

Feeding, Diving, Hauling out, and Social Behavior

Ringed seal pups are born and nursed in the spring (March through May), normally in subnicean birth lairs, with the peak of pupping occurring in early April (Frost and Lowry 1981). Subnivean lairs provide thermal protection from cold temperatures, including wind chill effects, and some protection from predators (Smith and Stirling 1975, Smith 1976). These lairs are especially important for protecting pups. Arctic ringed seals appear to favor shore-fast ice for whelping habitat. Ringed seal whelping has also been observed on both nearshore and offshore drifting pack ice (e.g., Lentfer 1972). Seal mothers continue to forage throughout lactation, and move young pups between lairs within their network of lairs. The pups spend time learning diving skills, using multiple breathing holes, and nursing and resting in lairs (Smith and Lydersen 1991, Lydersen and Hammill 1993). After a 5 to 8 week lactation period, pups are weaned (Lydersen and Hammill 1993, Lydersen and Kovacs 1999).

Mating is thought to take place under the ice in the vicinity of birth lairs while mature females are still lactating (Kelly et al. 2010). Ringed seals undergo an annual molt (shedding and regrowth of hair and skin) that occurs between mid-May to mid-July, during which time they spend many hours hauled out on the ice (Reeves 1998). The relatively long periods of time that ringed seals spend out of the water during the molt have been ascribed to the need to maintain elevated skin temperatures during new hair growth (Feltz and Fay 1966). Figure 26 summarizes the approximate annual timing of Arctic ringed seal reproduction and molting (Kelly et al. 2010).

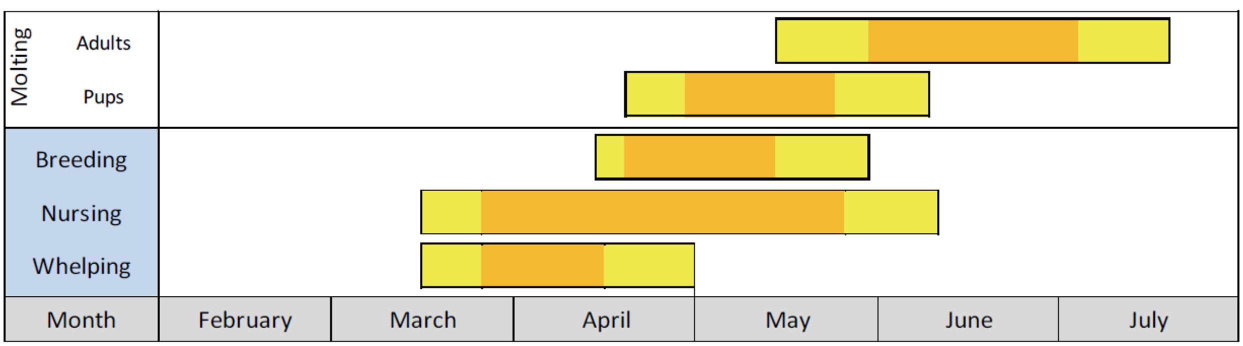


Figure 26. Approximate annual timing of Arctic ringed seal reproduction and molting. Yellow bars indicate the “normal” range over which each event is reported to occur and orange bars indicate the “peak” timing of each event (Kelly et al. 2010).

Ringed seals tend to haul out of the water during the daytime and dive at night during the spring to early summer breeding and molting periods, while the inverse tended to be true during the late summer, fall, and winter (Kelly and Quakenbush 1990, Lydersen 1991, Teilmann et al. 1999, Carlens et al. 2006, Kelly et al. 2010).

Ringed seals feed year-round, but forage most intensively during the open-water period and early freeze-up, when they spend 90 percent or more of their time in the water (Kelly et al. 2010). Many studies of the diet of Arctic ringed seal have been conducted and although there is considerable variation in the diet regionally, several patterns emerge. Most ringed seal prey is small, and preferred prey tends to be schooling species that form dense aggregations. Fish of the cod family tend to dominate the diet from late autumn through early spring in many areas

(Kovacs 2007). Arctic cod (*Boreogadus saida*) is often reported to be the most important prey species for ringed seals, especially during the ice-covered periods of the year (Lowry et al. 1980, Smith 1987, Holst et al. 2001, Labansen et al. 2007). Quakenbush et al. (2011) reported evidence that in general, the diet of Alaska ringed seals sampled consisted of cod, amphipods, and shrimp. Fish are generally more commonly eaten than invertebrate prey, but diet is determined to some extent by availability of various types of prey during particular seasons as well as preference, which in part is guided by energy content of various available prey (Reeves 1998, Wathne et al. 2000). Invertebrate prey seem to become more important in the diet of Arctic ringed seals in the open-water season and often dominate the diet of young animals (e.g., (Lowry et al. 1980, Holst et al. 2001).

Hearing, Vocalizations, and Other Sensory Capabilities

Ringed seals vocalize underwater in association with territorial and mating behaviors. Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz, and make calls between 90 Hz and 16 kHz (Richardson et al. 1995c). NMFS defines the function hearing range for phocids as 50 Hz to 86 kHz (NMFS 2018b).

Elsner et al. (1989) indicated that ringed seals primarily use vision to locate breathing holes from under the ice, followed by their auditory and vibrissal senses for short-range pilotage. Hyvärinen (1989) suggested that ringed seals in Lake Saimaa may use a simple form of echolocation along with a highly developed vibrissal sense for orientation and feeding in dark, murky waters. The vibrissae likely are important in detecting prey by sensing their turbulent wakes as demonstrated experimentally for harbor seals (Dehnhardt et al. 1998). Sound waves could be received by way of the blood sinuses and by tissue conduction through the vibrissae (Riedman 1990).

4.1.5 Bearded Seal (Beringia DPS)

Status and Population Structure

There are two recognized subspecies of the bearded seal: *E. b. barbatus*, often described as inhabiting the Atlantic sector (Laptev, Kara, and Barents seas, North Atlantic Ocean, and Hudson Bay; (Rice 1998); and *E. b. nauticus*, which inhabits the Pacific sector (remaining portions of the Arctic Ocean and the Bering and Okhotsk seas; Ognev 1935, Scheffer 1958, Manning 1974, Heptner et al. 1976). Based on evidence for discreteness and ecological uniqueness, NMFS concluded that the *E. b. nauticus* subspecies consists of two DPSs-the Okhotsk DPS in the Sea of Okhotsk, and the Beringia DPS, encompassing the remainder of the range of this subspecies (75 FR 77496; December 10, 2010). Only the Beringia DPS is found in U.S. waters (and the action area), and this portion is recognized by NMFS as a single Alaska stock.

NMFS listed the Beringia DPS and Okhotsk DPS of bearded seals as threatened under the ESA on December 28, 2012 (77 FR 76740).

A reliable population estimate for the entire Alaska stock is not available, but research programs have recently developed new survey methods and partial, but useful, abundance estimates. In spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). The data from these image-based surveys are still being analyzed, but for the U.S. portion of the Bering Sea, Boveng et al. (2017) reported model-averaged abundance estimates of 170,000 and 125,000 bearded seals in 2012 and 2013, respectively. These results reflect use of an estimate of availability (haulout correction factor) based on data from previously deployed satellite tags. The authors suggested that the difference in seal density between years may reflect differences in the numbers of bearded seals using Russian versus U.S. waters between years, and they noted that if this was the case, the eventual development of comprehensive estimates of abundance for bearded seals in the Bering Sea that incorporate data in Russian waters may show less difference between years.

Distribution

The Beringia DPS of the bearded seal includes all bearded seals from breeding populations in the Arctic Ocean and adjacent seas in the Pacific Ocean between 145°E longitude (Novosibirskiye) in the East Siberian Sea and 130°W longitude in the Canadian Beaufort Sea, except west of 157°W longitude in the Bering Sea and west of the Kamchatka Peninsula (where the Okhotsk DPS is found). The bearded seal’s effective range is generally restricted to areas where seasonal sea ice occurs over relatively shallow waters. Cameron et al. (2010) defined the core distribution of bearded seals as those areas of known extent that are in waters less than 500 m (1,640 ft) deep.

Bearded seals are closely associated with sea ice, particularly during the critical life history periods related to reproduction and molting, and can be found in a broad range of ice types. They generally prefer moving ice that produces natural openings and areas of open-water (Heptner et al. 1976, Fedoseev 1984, Nelson et al. 1984). They usually avoid areas of continuous, thick, shorefast ice and are rarely seen in the vicinity of unbroken, heavy, drifting ice or large areas of multi-year ice (Fedoseev 1965, Burns and Harbo 1972, Burns and Frost 1979, Burns 1981, Smith 1981, Fedoseev 1984, Nelson et al. 1984). Within the U.S. range of the Beringia DPS, the extent of favorable ice conditions for bearded seals is most restricted in the Beaufort Sea, where there is a relatively narrow shelf with suitable water depths. In comparison, suitable ice conditions and water depths occur in limited areas of the Chukchi Sea, and over much broader areas in the Bering Sea (Burns 1981). During winter, the central and northern parts of the Bering Sea shelf, where heavier pack ice occurs, have the highest densities of adult bearded seals (Heptner et al. 1976, Burns and Frost 1979, Burns 1981, Nelson et al. 1984, Cameron et al. 2018), possibly reflecting the favorable ice conditions there. In contrast, Cameron et al. (2018) found that young bearded seals were closely associated with the ice edge farther south in the Bering Sea. Spring surveys conducted in 1999 through 2000 along the Alaska coast of the Chukchi Sea, and in 2001 near St. Lawrence Island, indicated that bearded seals tended to prefer areas of between 70 and 90 percent ice coverage, and were typically more abundant in offshore pack ice 37 to 185 km (20 to 100 nautical miles [nm]) from shore than within 37 km (20 nm) from shore, except for high concentrations nearshore to the south of Kivalina (Simpkins et al. 2003, Bengtson et al. 2005).

It is thought that in the fall and winter most bearded seals move south with the advancing ice edge through Bering Strait into the Bering Sea where they spend the winter, and in the spring and early summer, as the sea ice melts, many of these seals move north through the Bering Strait into the Chukchi and Beaufort Seas (Burns 1967, Burns and Frost 1979, Burns 1981, Cameron and Boveng 2007, Cameron and Boveng 2009, Cameron et al. 2018). However, bearded seal vocalizations have been recorded year-round in the Chukchi and Beaufort Seas (MacIntyre et al.

2013, MacIntyre et al. 2015), indicating some unknown proportion of the population occurs there over winter. The overall summer distribution is quite broad, with seals rarely hauled out on land (Burns 1967, Heptner et al. 1976, Burns 1981, Nelson et al. 1984). However some seals, mostly juveniles, have been observed hauled out on land along lagoons and rivers in some areas of Alaska, such as in Norton Bay (Huntington 2000) and near Wainwright (Nelson 1981) and on sandy islands near Barrow (Cameron et al. 2010).

Occurrence in the Action Area

Although bearded seal vocalizations (produced by adult males) have been recorded nearly year-round in the Beaufort Sea (MacIntyre et al. 2013, MacIntyre et al. 2015), most bearded seals overwinter in the Bering Sea. In addition, during late winter and early spring, Foggy Island Bay is covered with shorefast ice and the nearest lead systems are at least several kilometers away, making the area unsuitable habitat for bearded seals. Therefore, bearded seals are not expected to be encountered in or near the LDPI portion of the action area during this time (from late winter through early spring).

During the open-water period, the Beaufort Sea likely supports fewer bearded seals than the Chukchi Sea because of the more extensive foraging habitat available to bearded seals in the Chukchi Sea. In addition, as a result of shallow waters, the sea floor in Foggy Island Bay south of the barrier islands is often scoured by ice, which limits the presence of bearded seal prey species. Nevertheless, aerial and vessel-based surveys associated with seismic programs, barging, and government surveys in this area between 2005 and 2010 reported several bearded seal sightings (Green and Negri 2005, Green and Negri 2006, Green et al. 2007, Funk et al. 2008, Hauser et al. 2008, Savarese et al. 2010, Clarke et al. 2011, Reiser et al. 2011). In addition, eight bearded seal sightings were documented during shallow geohazard seismic and seabed mapping surveys conducted in July and August 2014 (Smultea et al. 2014). Frouin-Mouy et al. (2016) conducted acoustic monitoring in Foggy Island Bay from early July to late September 2014, and detected pinniped vocalizations on 10 days via the nearshore recorder and on 66 days via the recorder farther offshore. Although the majority of these detections were unidentified pinnipeds, bearded seal vocalizations were positively identified on two days (Frouin-Mouy et al. 2016).

At present, there is no official population estimate for bearded seals occupying the Beaufort Sea, particularly in the coastal areas during the winter and spring. Industry monitoring surveys for the Northstar development during the spring seasons in 1999 (Moulton et al. 2000), 2000 (Moulton et al. 2001), 2001 (Moulton et al. 2002a), and 2002 (Moulton et al. 2003) counted 47 bearded seals (annual mean of 11.75 seals during an annual mean of 3,997.5 km^2 of effort, Table 11), and while the numbers were deemed too low to calculate a reliable density estimate in each year, no other on bearded seal presence were available. Figure 27 displays the bearded seals observed in 1999 (the year with the most observations). This figure provides a good representation of the locations bearded seals were observed over all 4 years (Richardson and Williams 2000). Annual reports (Richardson 2008) for years 2000 through 2002 include similar figures. Therefore, we have estimated a winter and spring density using the four years of Northstar development data of 0.003/km^2 bearded seals.

Table 11. Summary of available data on bearded seal sightings in and around Northstar development and Liberty Project areas.

Year	Number of Sightings	Effort (km^2)	Bearded Seals/km^2	Source
1999	20	3,980	0.005	(Moulton et al. 2000)
2000	15	4,245	0.004	(Moulton et al. 2001)
2001	3	4,147	0.001	(Moulton et al. 2002a)
2002	9	3,618	0.002	(Moulton et al. 2003)
Average	**11.75**	**3,997.5**	**0.003**	

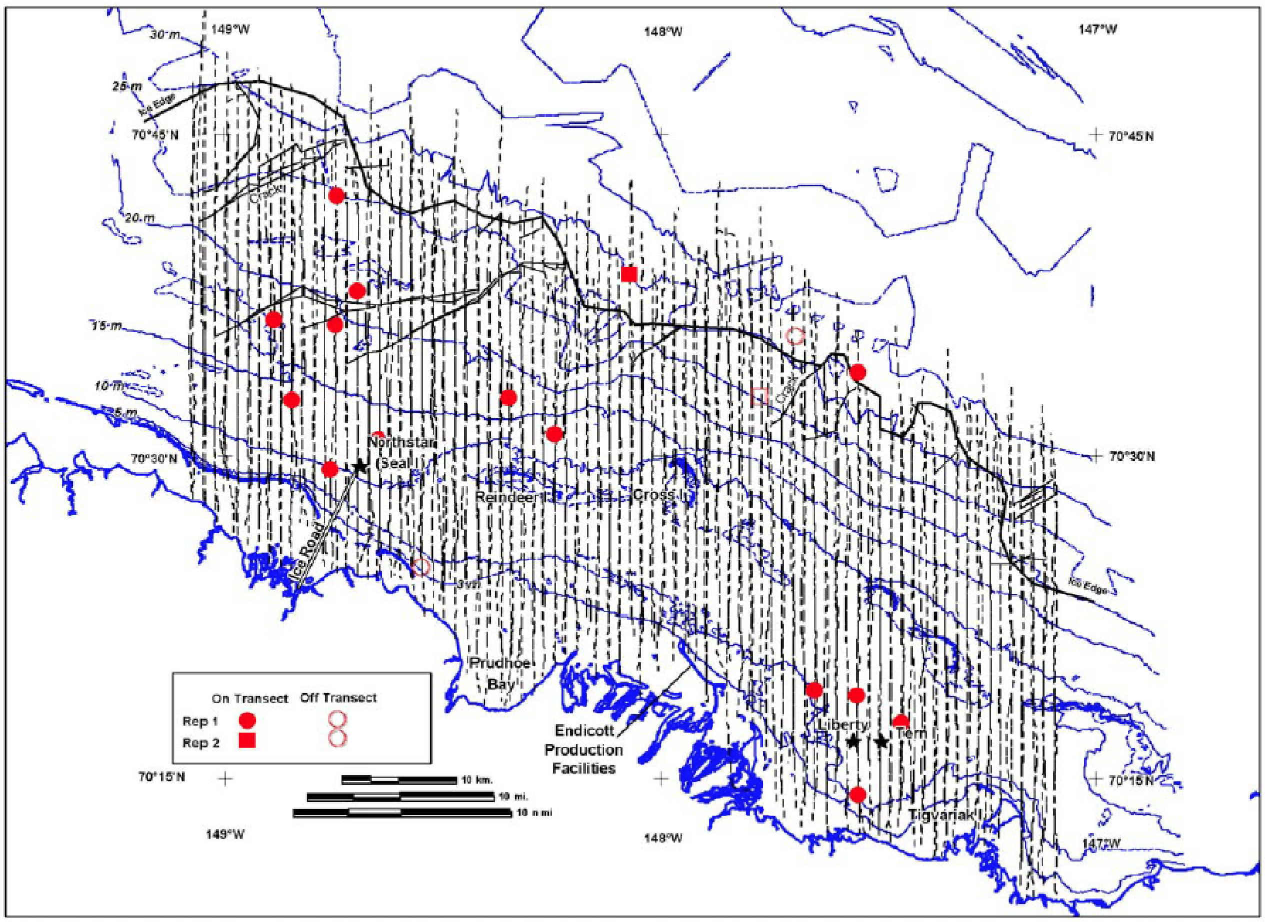


Figure 27. Distribution of bearded seal sighting during Northstar aerial surveys, 4-13 June 1999 (Richardson and Williams 2000).

To estimate the summer density of bearded seals, presence and sighting rates from monitoring programs within Foggy Island Bay and surrounding areas were used (Harris et al. 2001, Aerts et al. 2008, Hauser et al. 2008, Smultea et al. 2014). Of all the pinniped sightings during monitoring surveys, 63 percent were ringed seals, 17 percent were bearded seals, and 20 percent were spotted seals. Bearded seal density was calculated as a proportion of the ringed seal summer density of 0.27/km^2. Thus, the density of bearded seals during the open water season (summer and fall) was calculated as 17 percent of 0.27/km^2, resulting in an estimated of 0.05/km^2. There is no good information available on the presence or densities of bearded seals in the coastal areas of the Beaufort Sea during the fall, and therefore it is assumed that fall densities of bearded seals in Foggy Island Bay will be the same as the summer densities.

Feeding, Diving, Hauling out, and Social Behavior

Bearded seals feed primarily on a variety of invertebrates (crabs, shrimp, clams, worms, and snails) and some fish found on or near the seafloor (less than 200 m deep; (Burns 1981) (Heptner et al. 1976, Fedoseev 1984, Nelson et al. 1984, Cameron et al. 2010). They are believed to detect benthic prey by scanning the surface of the seafloor with their highly sensitive whiskers (Marshall et al. 2006). Bearded seals are considered opportunistic feeders whose diet varies with age, location, season, and changes in prey availability. Satellite tagging indicates that adults, subadults, and to some extent pups show some level of fidelity to feeding areas, often remaining in the same general area for weeks or months at a time (Cameron 2005, Cameron and Boveng 2009).

The diving behavior of adult bearded seals is closely related to their benthic foraging habits, and in the few studies conducted so far, dive depths have largely reflected local bathymetry (Gjertz et al. 2000, Krafft et al. 2000). Bearded seals typically dive to depths of less than 100 m (328 ft) for less than 10 minutes in duration, although dives of adults have been recorded up to 300 m (984 ft) and young-of-the-year have been recorded diving down to almost 500 m (1,640 ft; (Gjertz et al. 2000). Studies using depth recording devices have until recently focused on lactating mothers and their pups. Nursing mothers dive deeper on average than their pups, but by 6 weeks of age most pups had exceeded the maximum dive depth of lactating females (448 to 480 m [1,470 to 1,575 ft] versus 168 to 472 m [551 to 1,549 ft]; (Gjertz et al. 2000).

There are only a few quantitative studies concerning the activity patterns of bearded seals. Based on limited observations in the southern Kara Sea and Sea of Okhotsk it has been suggested that from late May to July bearded seals haul out more frequently on ice in the afternoon and early evening (Heptner et al. 1976). From July to April, three males (2 subadults and 1 young adult) tagged as part of a study in the Bering and Chukchi Seas rarely hauled out at all, even when occupying ice covered areas (Boveng and Cameron 2013). This is similar to both male and female young-of-year bearded seals tagged in Kotzebue Sound, Alaska (Frost et al. 2008). However, the diurnal pattern of haulout was different between the age classes in these two studies, with more of the younger animals hauling out in the late evening (Frost et al. 2008) verse adults favoring afternoon in June and evening from fall into spring (Boveng and Cameron 2013).

Studies using data recorders and telemetry on lactating females and their dependent pups showed that, unlike other large phocid seals, bearded seals are highly aquatic during a nursing period of about three weeks (Lydersen and Kovacs 1999). At Svalbard Archipelago, nursing mothers spent more than 90 percent of their time in the water, split equally between near-surface activity and diving or foraging (Holsvik 1998, Krafft et al. 2000), while dependent pups spent about 50 percent of their time in the water, split between the surface (30 percent) and diving (20 percent; (Lydersen et al. 1994, Lydersen et al. 1996, Watanabe et al. 2009). Mothers traveled 48 km (30 mi) per day on average, and alternated time in the water with one to four short bouts on the ice to nurse their pups (Krafft et al. 2000).

In the spring, adult males are suspected to spend a majority of their time in the water vocalizing and defending territories, though a few observations suggest they are not entirely aquatic and may haul out near females with or without pups (Burns 1967, Fedoseev 1971, Finley and Renaud 1980).

Hearing and Vocalization

Bearded seals vocalize underwater in association with territorial and mating behaviors. The predominant calls produced by males during breeding, termed trills, are described as frequency modulated vocalizations. Trills show marked individual and geographical variation, are uniquely identifiable over long periods, can propagate up to 30 km (19 mi), are up to 60 seconds in duration, and are usually associated with stereotyped dive displays (Cleator et al. 1989, Van Parijs et al. 2001, Van Parijs 2003, Van Parijs et al. 2003, Van Parijs et al. 2004, Van Parijs and Clark 2006).

Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz, and make calls between 90 Hz and 16 kHz (Richardson et al. 1995c). NMFS defines the function hearing range for phocids as 50 Hz to 86 kHz (NMFS 2018b).

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).

Existing Stressors within the Action Area

The following discussion summarizes the principal natural and anthropogenic stressors that affect bowhead whales, ringed seals, and bearded seals:

- Predation and disease
- Targeted hunts
- Ambient and anthropogenic noise
- Oil and gas development
- Pollutants and contaminants
- Vessel and fisheries interactions
- Research
- Climate change

For more information on all stressors affecting the ESA-listed species considered in depth in this opinion, please refer to the following documents:

- "Alaska Marine Mammal Stock Assessments, 2016" (Muto et al. 2017), Available online at https://www.fisheries.noaa.gov/resource/%7Bpath_utils%7D/alaska-marine-mammal-stock-assessments-2016
- "Status Review of the Ringed Seal (*Phoca hispida*)" (Kelly et al. 2010), Available online at http://www.nmfs.noaa.gov/pr/species/Status%20Reviews/Ringed%20seal%202012_.pdf"
- "Status Review of the Bearded Seal (*Erignathus barbatus*)" (Cameron et al. 2010), Available online at http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-211.pdf

Biotoxins, Disease, and Predation

As temperatures in the Arctic waters are warming and sea ice is diminishing, there is an increased potential for harmful algal blooms that produce toxins to affect marine life (see Figure 28). Biotoxins like domoic acid and saxitoxin may pose a risk to Arctic marine mammals. In additions increased temperatures can increase in Brucella infections. 905 marine mammals from 13 species were sampled including; humpback whales, bowhead whales, beluga whales, harbor porpoises, northern fur seals, Steller sea lions, harbor seals, ringed seals, bearded seals, spotted seals, ribbon seals, Pacific walruses, and northern sea otters. Domoic acid was detected in all 13 species examined and had the greatest prevalence in bowhead whales (68%) and harbor seals (67%). Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales (50%) and bowhead whales (32%) (Lefebvre et al. 2016).

Figure 28. Algal toxins detected in 13 species of marine mammals from southeast Alaska to the Arctic from 2004 to 2013 (Lefebvre et al. 2016).

Bowhead Whales

Little is known about the natural mortality of bowhead whales (Philo et al. 1993). From 1964 through the early 1990s, at least 36 deaths were reported in Alaska, Norway, Yukon and Northwest Territories for which the cause could not be established (Philo et al. 1993). Bowhead whales have no known predators except perhaps killer whales. The frequency of attacks by killer whales upon the Western Arctic stock of bowhead whales is assumed to be low (George et al. 1994). Of 195 whales examined from the Alaskan subsistence harvest between 1976 and 1992, .1 to 7.9 percent had scars indicating that they had survived attacks by killer whales (George et al. 1994). Of 378 complete records for killer whale scars collected from 1990 to 2012, 30 whales (8 percent) had scarring “rake marks” consistent with orca/killer whale injuries and another 10 had possible injuries (George et al. 2017).

Ringed and Bearded Seals

Polar bears are the main predator of ringed and bearded seals (Cameron et al. 2010, Kelly et al. 2010). Other predators of both species include walruses and killer whales (Burns and Eley 1976, Heptner et al. 1976, Fay et al. 1990, Derocher et al. 2004, Melnikov and Zagrebin 2005). In addition, Arctic foxes prey on ringed seal pups by burrowing into lairs; and gulls, ravens, and possibly snow owls successfully prey on pups when they are not concealed in lairs (Smith 1976, Kelly et al. 1986, Lydersen et al. 1987, Lydersen and Smith 1989, Lydersen and Ryg 1990, Lydersen 1998). The threat currently posed to ringed and bearded seals by predation is considered moderate, but predation risk is expected to increase as snow and sea ice conditions change with a warming climate (Cameron et al. 2010, Kelly et al. 2010).

Ringed and bearded seals have co-evolved with numerous parasites and diseases, and these relationships are presumed to be stable. Abiotic and biotic changes to ringed and bearded seal habitat could lead to exposure to new pathogens or new levels of virulence, but the potential threats to these seals is considered low (Cameron et al. 2010, Kelly et al. 2010). Beginning in mid-July 2011, elevated numbers of sick or dead seals, primarily ringed seals, with skin lesions were discovered in the Arctic and Bering Strait regions. By December 2011, there were more than 100 cases of affected pinnipeds, including ringed seals, bearded seals, spotted seals, and walruses, in northern and western Alaska. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, NMFS and USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on December 20, 2011. Disease surveillance efforts in 2012 through 2014 detected few new cases similar to those observed in 2011. To date, no specific cause for the disease has been identified.

During spring and summer of 2019, the NMFS AKR Stranding Network received reports of many stranded ice seals; as of August 8 there were 142 reports (137 dead and 5 alive), including at least 19 ringed seals and 44 bearded seals (and 60 unidentified seals, some of which may have been ringed or bearded seals). The cause, or causes, of these deaths is currently being investigated by NMFS, and NMFS is considering declaring an Unusual Mortality Event (UME).

Targeted hunts

Bowhead Whales

Whaling by Alaska Natives in the Alaskan Arctic and sub-arctic has taken place for at least 2,000 years (Marquette and Bockstoce 1980, Stoker and Krupnik 1993). In addition to subsistence hunting, commercial whaling occurred during the late 19th and early 20th centuries. Pelagic commercial whaling for the Western Arctic stock of bowheads was conducted from 1849 to 1914 in the Bering, Chukchi, and Beaufort Seas (Bockstoce et al. 2005). Woodby and Botkin (1993) estimated that the historical abundance of bowhead whales in this population was between 10,400 and 23,000 whales before commercial whaling began. Within the first two decades (1850 through 1870), over 60 percent of the estimated pre-whaling population was harvested, although whaling effort remained high into the 20th century (Braham 1984). It is estimated that the pelagic whaling industry harvested 18,684 whales from this stock (Woodby and Botkin 1993). Between 1848 and 1919, shore-based whaling operations (including landings as well as struck and lost estimates from U. S., Canada, and Russia) took an additional 1,527 animals (Woodby and Botkin 1993). Estimates of mortality likely underestimate the actual harvest as a result of under-reporting of the Soviet catches (Yablokov 1994) and incomplete reporting of struck and lost animals. Commercial whaling also may have caused the extinction of some subpopulations and some temporary changes in distribution.

Subsistence harvest has been regulated by quotas set by the IWC and allocated by the Alaska Eskimo Whaling Commission since 1977. Alaska Native subsistence hunters, primarily from 11 Alaska communities, take approximately 0.1 to 0.5 percent of the population per annum (Philo et al. 1993, Suydam et al. 2011). Under this quota, the number of kills in any one year has ranged between 14 and 72. The maximum number of strikes per year is set by a quota which is determined by subsistence needs and bowhead whale abundance and trend estimates (Stoker and Krupnik 1993). Suydam and George (2012) summarized Alaska subsistence harvests of bowhead whales from 1974 to 2011 by village and reported that a total of 1,149 whales were landed by hunters from 12 villages, with Barrow landing the most whales (n = 590) and Shaktoolik landing only one. The number of whales landed at each village varies greatly from year to year, as success is influenced by village size and ice and weather conditions (Table 12). The efficiency of the hunt (the percent of whales struck that are retrieved) has increased since the implementation of the bowhead whale quota in 1978. In 1978, the efficiency was about 50 percent. In 2016, 47 of 59 whales struck were landed, resulting in an efficiency of 80 percent, which was slightly higher than the previous 10-year average of 75 percent (Suydam et al. 2017).

Table 12. Annual number of bowhead whales landed by Alaska natives.

Year	Number of Landed Whales
2010	45
2011	38
2012	55
2013	46
2014	38
2015	38
2016	47
2017	43
Sources: (Suydam et al. 2011, Suydam et al. 2012, Suydam et al. 2013, Suydam et al. 2014, Suydam et al. 2015, Suydam et al. 2016, 2017, AEWC unpublished data, 2017)	

Canadian and Russian Natives also take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik harvested one whale in 1991 and one in 1996. No catches for Western Arctic bowhead whales were reported by either Canadian or Russian hunters for 2006 and 2007 (IWC 2008, 2009) or by Russia in 2009, 2011, 2012, or 2014 (IWC 2011, Ilyashenko 2013, Ilyashenko and Zharijov 2015), but two bowhead whales were taken in Russia in 2008 (IWC 2010), two in 2010 (IWC 2012), and one in 2013 (Ilyashenko and Zharijov 2014). Annual subsistence take by Natives of Alaska, Russia, and Canada from 2010 through 2014 averaged 44 bowhead whales. During the 2013 through 2018 time period, the IWC and AEWC are allowing Alaskan and Chukotkan whalers to land up to 336 bowhead whales total (AEWC 2018).

Ringed and Bearded Seals

While the United States does not allow commercial harvest of marine mammals, including of ringed and bearded seals, such harvests are permitted in other portions of the species' ranges. Local population depletions occurred during the 20th century as a result of commercial harvests; however, commercial harvest is not considered to currently pose a significant threat to ringed or bearded seals (Cameron et al. 2010, Kelly et al. 2010).

Ringed and bearded seals are important subsistence species for many northern coastal communities. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ringed and bearded seals for subsistence purposes (Ice Seal Committee 2016). Estimates of subsistence harvest of ringed and bearded seals are available for 17 of these communities based on annual household surveys conducted from 2009 through 2014 (Table 13), but more than 50 other communities that harvest these species for subsistence were not surveyed within this time period or have never been surveyed. Household surveys are designed to estimate harvest for the specific community surveyed; extrapolation of harvest estimates beyond a specific community is not appropriate because of local differences in seal availability, cultural hunting practices, and environmental conditions (Ice Seal Committee 2017). During 2010 through 2014, the total annual ringed and bearded seal harvest estimates across surveyed communities ranged from 695 to 1,286 and 217 to 1,176, respectively (Table 13). However, it should be noted that the geographic distribution of communities surveyed varied among years such that these totals may be geographically or otherwise biased.

Table 13. Alaska ringed and bearded seal harvest estimates based on household surveys, 2010–2014 (Ice Seal Committee 2017).

Community	Estimated Ringed Seal Harvest					Estimated Bearded Seal Harvest				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Nuiqsut	-	-	-	-	58	-	-	-	-	26
Utqiaġvik	-	-	-	-	428	-	-	-	-	1,070
Point Lay	-	-	51	-	-	-	-	55	-	-
Kivalina	-	16	-	-	-	-	123	-	-	-
Noatak	-	3	-	-	-	-	65	-	-	-
Buckland	-	26	-	-	-	-	48	-	-	-
Deering	-	0	-	-	-	-	49	-	-	-
Golovin	-	-	0	-	-	-	-	11	-	-
Emmonak	-	56	-	-	-	-	106	-	-	-
Scammon Bay	-	137	169	-	-	-	82	51	-	-
Hooper Bay	458	674	651	667	158	148	210	212	171	64
Tununak	162	257	219	-	-	40	42	44	-	-
Tuntutuliak	-	-	-	75	-	-	-	-	53	-
Quinhagak	163	117	140	160	51	29	26	44	49	16
Togiak	1	0	-	-	-	0	2	-	-	-
Twin Hills	0	-	-	-	-	0	-	-	-	-
Dillingham	-	-	3	-	-	-	-	7	-	-
Total	784	1,286	1,233	902	695	217	753	424	273	1,176
Source: (Ice Seal Committee 2017)										

Ambient and Anthropogenic Noise

Ambient Noise

Ambient noise is the typical environmental soundscape or background sound pressure level at a given location. Generally, a new signal or sound would be detectable only if it is stronger than the ambient noise at similar frequencies. There are many sources that influence ambient noise in the ocean, including wind, waves, ice, rain, and hail; sounds produced by living organisms; noise from volcanic and tectonic activity; and thermal noise that results from molecular agitation (which is important at frequencies greater than 30 kHz).

The presence of ice can contribute substantially to ambient sound levels and affects sound propagation. While sea ice can produce substantial amounts of ambient sounds, it also can function to dampen or heighten ambient sound. Smooth annual ice can enhance sound propagation compared to open water conditions (Richardson et al. 1995c). However, with increased cracking, ridging, and other forms of sub-surface deformation, transmission losses generally become higher compared to open water (Richardson et al. 1995c, Blackwell and Greene 2001). Urick (1983) discussed variability of ambient noise in water, including under Arctic ice; he stated that “the ambient background depends upon the nature of ice, whether continuous, broken, moving or shore-fast, the temperature of air, and the speed of the wind.” Temperature affects the mechanical properties of the ice, and temperature changes can result in cracking. The spectrum of cracking ice sounds typically displays a broad range from 100 Hz to 1 kHz, and the spectrum level has been observed to vary as much as 15 dB re 1 μPa at 1 m within 24 hours due to diurnal variability in air temperatures (BOEMRE (Bureau of Ocean Energy Management 2011). Data are limited, but in at least one instance it has been shown that ice-deformation sounds produced frequencies of 4 to 200 Hz (Greene 1981).

During the open-water season in the Arctic, wind and waves are important sources of ambient sound with levels tending to increase with increased wind and sea state, all other factors being equal (Richardson et al. 1995c). Wind, wave, and precipitation noise originating close to the point of measurement dominate frequencies from 500 to 50,000 Hz.

There are many marine mammals in the Arctic marine environment whose vocalizations contribute to ambient sound including, but not limited to, bowhead whales, gray whales, beluga whales, walrus, ringed seals, and spotted seals. Walrus, seals, and seabirds all produce sound that can be heard in air as well. Underwater sound source levels of bearded seal songs have been estimated to be up to 178 dB re 1 μPa at 1 m depth (Ray et al. 1969) as cited in (Stirling et al. 1983, Richardson et al. 1995c, Thomson and Richardson 1995). Ringed seal calls have a source level of 95 to 130 dB re 1 μPa at 1 m, with the dominant frequency under 5 kHz (Cummings et al., 1986 as cited in Thomson and Richardson 1995). Bowhead whales produce sounds with estimated source levels ranging from 128 to 189 dB re 1 μPa at 1 m in frequency ranges from 20 to 3,500 Hz. Thomson and Richardson (1995) summarized that most bowhead whale calls are “tonal frequency-modulated” sounds at 50 to 400 Hz.

Ambient noise levels recorded during the open-water season (July 6 through September 22) near the Liberty site varied from approximately 88 to 103 dB re uPa broadband (Aerts et al. 2008). These ambient noise levels may have been influenced by other vessel activities occurring nearby (Aerts et al. 2008). Broadband background sound levels recorded in the water under the ice at 9.4 km (5.8 mi) from Northstar Island were 77 dB 1 re μPa and 76 dB re μPa in 2001 and 2002, respectively (Blackwell et al. 2004b).

Anthropogenic Noise

Anthropogenic sources (human-caused) of noise in the action area include vessels, shipping, oil and gas activities, geophysical surveys (including seismic activities), drilling, construction, dredging, pile-driving, icebreaking, sonars, and aircraft. The combination of anthropogenic and natural noises contributes to the total noise at any one place and time. Levels of anthropogenic sound can vary dramatically depending on the season, type of activity, and environmental conditions. Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (NRC 1994, Richardson et al. 1995c, NRC 1996, NRC 2000, NRC 2003, Jasny et al. 2005, NRC 2005). Because responses to anthropogenic noise vary among species and individuals within species, it is difficult to determine long-term effects. Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013). Clark et al. (2009b) identified increasing levels of anthropogenic noise as a habitat concern for whales because of its potential effect on their ability to communicate (i.e. masking). Some research (Parks 2003, McDonald et al. 2006a, Parks 2009) suggests marine mammals compensate for masking by changing the frequency, source level, redundancy, and timing of their calls. However, the long-term implications of these adjustments, if any, are currently unknown. Additional information on anthropogenic noise sources can also be found in Section 5.1.1 (*Noise Related to Oil and Gas Activities*) and Section 5.1.2 (*Vessel Noise*).

Oil and Gas Development

Offshore petroleum exploration activities have been conducted in State of Alaska waters and the OCS of the Beaufort and Chukchi Sea Planning Areas, in Canada’s eastern Beaufort Sea off the Mackenzie River Delta, in Canada’s Arctic Islands, and in the Russian Arctic, and around Sakhalin Island in the Sea of Okhotsk (NMFS 2016).

5.1.1 Noise Related to Oil and Gas Activities

Anthropogenic noise levels in the Beaufort Sea are higher than in the Chukchi Sea due to nearshore and onshore oil and gas development on the Alaskan North Slope, particularly in the vicinity of Prudhoe Bay. In the central Beaufort Sea in Alaska, oil and gas exploration, development, and production activities there include, but are not limited to: seismic surveys; exploratory, delineation, and production drilling operations; construction of artificial islands, causeways, ice roads, shore-based facilities, and pipelines; and vessel and aircraft operations. Stressors associated with these activities that are of primary concern for marine mammals include noise, physical disturbance, and pollution, particularly in the event of a large oil spill.

Oil and gas exploration activities have occurred on the North Slope since the early 1900s, and oil production started at Prudhoe Bay in 1977. Oil production has occurred for over 40 years in the region, and presently spans from the Alpine-field, which is approximately 96 km (60 mi) west of Prudhoe Bay, to the Point Thomson project, which is approximately 96 km east of Prudhoe Bay. Additionally, onshore gas production from the Barrow gas field began over 60 years ago. Associated industrial development has included the creation of industry-supported community airfields at Deadhorse and Kuparuk, and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks.

In 1977, the Trans-Alaska Pipeline System began to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska. Today, it continues to transport the North Slope’s entire onshore and offshore oil production, and it is projected to do so for years into the future. Endicott SDI, built in 1987, was constructed to support the first continuous production of oil from an offshore field in the Arctic. Subsequently, the Northstar offshore island was constructed in 1999 and 2000 to support oil production. Northstar, as well as the Nikaitchuq and Oooguruk developments, currently operates in nearshore areas of the Beaufort Sea, and is expected to continue operating in the future. Other oil and gas related activities that have occurred in the

Beaufort Sea and Chukchi Sea OCS to date include exploratory drilling, exploration seismic surveys, geohazard surveys, geotechnical sampling programs, and baseline biological studies and surveys. There are also several exploration and development projects occurring on the North Slope including Greater Moose's Tooth 1 and 2, Smith Bay, Nuna, and Nanushuk. In addition, the Alaska Gasoline Development Corporation is developing the Alaska Stand-Alone Gas Pipeline that would extend from the North Slope to Southcentral Alaska. The project would include barging to the North Slope and modifications to West Dock.

Seismic surveys have been conducted in the Chukchi Sea and Beaufort Sea since the late 1960s and early 1970s, resulting in extensive coverage over the area. Seismic surveys vary, but a typical 2D/3D seismic survey with multiple guns emits sound at frequencies of about 10 Hz to 3 kHz (Austin et al. 2015). Seismic airgun sound waves are directed towards the ocean bottom, but can propagate horizontally for several kilometers (Greene and Richardson 1988, Greene and Moore 1995). Analysis of sound associated with seismic operations in the Beaufort Sea and central Arctic Ocean during ice-free conditions also documented propagation distances up to 1, 300 km (808 mi; Richardson 1998, 1999, Thode et al. 2010). Because the Chukchi Sea continental shelf has a highly uniform depth of 30 to 50 m (98 to 164 ft), it strongly supports sound propagation in the 50 to 500 Hz frequency band (Funk et al. 2008).

NMFS has conducted numerous ESA section 7 consultations related to oil and gas activities in the Beaufort Sea. Many of the consultations have authorized the take (by harassment) of bowhead whales and ringed and bearded seals (as well as non ESA-listed marine mammals) from sounds produced during geophysical (including seismic) surveys and other exploration and development activities.

In 2013, NMFS completed an incremental step consultation with BOEM and BSEE on the effects of the authorization of oil and gas leasing and exploration activities in the U.S. Beaufort and Chukchi Seas over a 14-year period, from March 2013 to March 2027 (i.e., the Arctic Regional Biological Opinion; NMFS 2013). The incidental take statement issued with the biological opinion for the 14-year period allows for takes (by harassment) from sounds associated with high-resolution, deep penetration, and in-ice deep penetration seismic surveys of 87,878 bowhead whales, 896 fin whales, 1,400 humpback whales, 91,616 bearded seals, and 506,898 ringed seals. Take will be more accurately evaluated and authorized for project-specific consultations that fall under this over-arching consultation (i.e., stepwise consultations), and the cumulative take for all subsequent consultations will be tracked and tiered to these consultations.

In addition, NMFS completed an incremental step consultation with BOEM and BSEE in 2015 on the effects of oil and gas exploration activities for lease sale 193 in the Chukchi Sea, Alaska, over a nine-year period, from June 2015 to June 2024 (NMFS 2015a). The incidental take statement issued with the biological opinion allows for takes (by harassment) from sounds associated with seismic, geohazard, and geotechnical surveys, and exploratory drilling of 8,434 bowhead whales, 133 fin whales, 133 humpback whales, 1,045,985 ringed seals, and 832,013 bearded seals.

In 2014, NMFS Alaska Region conducted three internal consultations with NMFS Permits Division on the issuance of IHAs to take marine mammals incidental to 3D ocean bottom sensor seismic and shallow geohazard surveys in Prudhoe Bay, Foggy Island Bay, and the Colville River Delta, in the Beaufort Sea, Alaska, during the 2014 open-water season (NMFS 2014c, b, a). These project-specific consultations were either directly or indirectly linked to the Arctic regional biological opinion. The incidental take statements issued with the three biological opinions allowed for takes (by harassment) of 138 bowhead whales, 744 bearded seals, and 427 ringed seals, total, as a result of exposure to impulsive sounds at received levels at or above 160 dB re 1 μPa_{rms}.

In 2015, NMFS Alaska Region conducted two internal consultations with NMFS Permits Division on the issuance of IHAs to take marine mammals incidental to shallow geohazard and 3D ocean bottom node seismic surveys in the Beaufort Sea, Alaska, during the 2015 open-water season. These consultations were also either directly or indirectly linked to the Arctic regional biological opinion. The incidental take statements in the three biological opinions estimated 461 bowhead whales, 202 bearded seals, and 1,472 ringed seals, total, would be taken (by harassment) as a result of exposure to impulsive sounds at received levels at or above 160 dB re 1 μPa_{rms} and one bowhead whale, 10 bearded seals, and 20 ringed seals as a result of exposure to impulsive sounds at received levels at or above 180 dB re 1 μPa_{rms}.

In 2015, NMFS Alaska Region conducted an internal consultation with NMFS Permits Division on the issuance of an IHA to take marine mammals incidental to ice overflight and ice survey activities conducted by Shell Gulf of Mexico and Shell Offshore Inc., from May 2015 to April 2016 (NMFS 2015c). The incidental take statement issued with the biological opinion authorized takes (by harassment) of 793 ringed seals and 11 bearded seals as a result of exposure to visual and acoustic stimuli from aircraft.

The first stepwise (i.e., tiered) consultation under the lease sale 193 incremental step consultation was conducted in 2015. NMFS Alaska Region consulted with the NMFS Permits Division on the issuance of an IHA to take marine mammals incidental to exploration drilling activities in the Chukchi Sea, Alaska, in 2015 (NMFS 2015b). The incidental take statement issued with the biological opinion allowed for takes (by harassment) of 1,083 bowhead whales, 14 fin whales, 14 humpback whales, 1,722 bearded seals, and 25,217 ringed seals as a result of exposure to continuous and impulsive sounds at received levels at or above 120 dB re 1 μPa_{rms} and 160 dB re 1 μPa_{rms}, respectively.

There were no consultations for oil and gas activities completed with the NMFS Permits Division in 2016 and 2017.

Anticipated impacts by harassment from noise associated with oil and gas activities generally include changes in behavioral state from low energy states (i.e., foraging, resting, and milling) to high energy states (i.e., traveling and avoidance).

Other Arctic Projects

In the winters of 2014, 2017, and 2018, the U.S. Navy has conducted submarine training, testing, and other research activities in the northern Beaufort Sea and Arctic Ocean from a temporary camp constructed on an ice flow toward the northern extent of the U.S. Economic Zone, about 185 to 370 km (115 to 230 mi) north of Prudhoe Bay. Equipment, materials, and personnel were transported to and from the ice camp via daily flights based out of the Deadhorse Airport (located in Prudhoe Bay). The Navy has a NPDES permit from EPA for discharges from camp operations for discharge greywater and reject water.

In 2016, NMFS Alaska Region conducted internal consultations with NMFS Permits Division on the issuance of three IHAs to take marine mammals incidental to dock construction, fiber optic cable laying, and anchor retrieval in the Bering, Chukchi, and Beaufort Seas, during the 2016 open water season. The incidental take statements issued with the three biological opinions allowed for takes (by harassment) of 788 bowhead whales, 19 fin whales, 13 humpback whales, 706 bearded seals, 7,887 ringed seals, and 2,185 western DPS Steller sea lion total, as a result of exposure to continuous or impulsive sounds at received levels at or above 120 dB or 160 dB re 1 μPa rms respectively.

Fiber optic cable laying continued in 2017, and NMFS Alaska Region conducted a consultation with NMFS Permits Divison on the issuance of an IHA for this project. Quintillion was permitted to install 1,904 km (1,183 mi) of subsea fiber optic cable during the open-water season, including a main trunk line and six branch lines to onshore facilities in Nome, Kotzebue, Point Hope, Wainwright, Barrow, and Oliktok Point. The incidental take statement issued with the biological opinion allowed for takes (by harassment) of 314 bowhead whales, 15 fin whales, 3 Western North Pacific DPS humpback whales, 7 Mexico DPS humpback whales, 62 bearded seals, 855 ringed seals, and 8 Western DPS Steller sea lions, total, as a result of exposure to sounds of received levels at or above 120 dB re 1 μPa_{rms} from sea plows, anchor handling, and operation and maintenance activities (NMFS 2017).

In 2018, NMFS Alaska Region conducted internal consultations with NMFS Permits Division and Office of Naval Research on the issuance of an IHA to take marine mammals incidental to activities including acoustic propagation experiments from 2018 to 2021. The research is to assess the effects of the changing Arctic environment on acoustic propagation, measure the varying temperature profile of the ocean and oceanography, and to test the feasibility of using a field of active acoustic sources as navigation aids to unmanned vehicles collecting oceanographic and ice data under ice-covered conditions. The IHA authorized takes of 3,071 ringed seals and 5 bearded seal takes from 2018 to 2019. NMFS Permits Division and ONR requested reinitiation in 2019, this biological opinion allows for the takes of 15,690 ringed seals and 15 bearded seals from 2019 through 2021.

Pollutants and Contaminants

Authorized Discharge

Discharges authorized from development activities occurring in portions of the action area are the source of multiple pollutants that may be bioavailable (i.e., may be taken up and absorbed by animals) to ESA-listed species and their prey items (NMFS 2016). Drill cuttings and fluids contain contaminants such as dibenzofuran and polycyclic aromatic hydrocarbons that have high potential for bioaccumulation. Historically, drill cuttings and fluids have been discharged from oil and gas developments in the Beaufort Sea near the action area, and residues from these historical discharges may be present in the environment (Brown et al. 2010). Polycyclic aromatic hydrocarbons are also emitted to the atmosphere by flaring water gases at production platforms or gas treatment facilities. For example, approximately 162,000 million standard cubic feet of waste gas was flared at Northstar in 2004 (Neff 2010).

The Clean Water Act of 1972 (CWA) has several sections or programs applicable to activities in offshore waters. Section 402 of the CWA authorizes the U.S. Environmental Protection Agency (EPA) to administer the National Pollutant Discharge Elimination System (NPDES) permit program to regulate point source discharges into waters of the United States. Section 403 of the CWA requires that EPA conduct an ocean discharge criteria evaluation for discharges of pollutants from point sources into the territorial seas, contiguous zones, and the oceans. The Ocean Discharge Criteria (40 CFR part 125, subpart M) sets forth specific determinations of unreasonable degradation that must be made before permits may be issued.

On November 28, 2012, EPA issued a NPDES general permit for discharges from oil and gas exploration facilities on the outer continental shelf and in contiguous state waters of the Beaufort Sea (Beaufort Sea Exploration GP). The general permit authorizes 13 types of discharges from exploration drilling operations and establishes effluent limitations and monitoring requirements for each waste stream.

On January 21, 2015, EPA issued a NPDES general permit for wastewater discharges associated with oil and gas geotechnical surveys and related activities in Federal waters of the Beaufort and Chukchi Seas (Geotechnical GP). This general permit authorizes twelve types of discharges from facilities engaged in oil and gas geotechnical surveys to evaluate the subsurface characteristics of the seafloor and related activities in federal waters of the Beaufort and Chukchi Seas.

Both the Beaufort Sea Exploration GP and the Geotechnical GP establish effluent limitations and monitoring requirements specific to each type of discharge and include seasonal prohibitions and area restrictions for specific waste streams. For example, both general permits prohibit the discharge of drilling fluids and drill cuttings to the Beaufort Sea from August 25 until fall bowhead whale hunting activities by the communities of Nuiqsut and Kaktovik have been completed. Additionally, both general permits require environmental monitoring programs to be conducted at each drill site or geotechnical site location, corresponding to before, during, and after drilling activities, to evaluate the impacts of discharges from exploration and geotechnical activities on the marine environment.

The principal regulatory mechanism for controlling pollutant discharges from vessels (grey water, black water, coolant, bilge water, ballast, deck wash, etc.) into waters of the Arctic Region OCS is also the Clean Water Act (CWA) of 1972. The EPA issued a NPDES vessel general permit effective from December 19, 2013, to December 18, 2018, that applies to pollutant discharges from non-recreational vessels that are at least 24 m (79 ft) in length, as well as ballast water discharged from commercial vessels less than 24 m. This general permit restricts the seasons and areas of operation, as well as discharge depths, and includes monitoring requirements and other conditions.

In addition, the U.S. Coast Guard has issued regulations that address pollution prevention with respect to discharges from vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water (33 CFR part 151). The State of Alaska regulates water quality standards within three miles of the shore.

Accidental Discharges - Oil Spills and Gas Releases

BOEM and BSEE define small oil spills as <1,000 barrels (bbl). Large oil spills are defined as 1,000-150,000 bbl, and very large oil spills (VLOS) are defined as ≥ 150,000 bbl (BOEM 2017a).

Small Oil Spills

Offshore petroleum exploration activities have been conducted in State of Alaska waters adjacent of the Beaufort and Chukchi Seas since the late 1960s. Based on a review of potential discharges and on the historical oil spill occurrence data for the Alaska OCS and adjacent State of Alaska waters, several small spills in the Beaufort Sea from refueling operations (primarily at West Dock) were reported to the National Response Center. Small oil spills have occurred with routine frequency and are considered likely to occur (BOEM 2017a).

In the past 30 years, only 43 wells have been drilled in the Beaufort and Chukchi Sea lease program areas. From 1985 to 2013, eight crude oil spills of ≥ 550 bbl were documented along the Alaska North Slope, one of which was ≥ 1,000 bbl. During the same time period, total North Slope production was 12.80 billion bbl (Bbbl) of crude oil and condensate. From 1971 through 2011, the highest mean volume of North Slope spills was from pipelines. The mean spill size for pipelines was 145 bbl. The spill rate for crude oil spills ≥ 500 bbl from pipelines (1985 to 2013) was 0.23 pipeline spills per Bbbl of oil produced (BOEM 2016c).

Large Oil Spills and Very Large Oil Spills

The large OCS spill-size assumption BOEM used for the Liberty spill analysis are based on reported spills in the Gulf of Mexico and Pacific OCS because no large spills (≥ 1,000 bbl) have occurred on the Alaska or Atlantic OCS from oil and gas activities (BOEM 2017b).

The loss of well control (LOWC) occurrence frequencies, per well, are on the order of 10^{-3} to 10^{-6}. The occurrence frequencies depend upon the operation or activity, whether the LOWC was a blowout or well release, and whether there was oil spilled (BOEM 2017b).

In general, historical data show that LOWC events escalating into blowouts and resulting in oil spills are infrequent and that those resulting in large accidental oil spills are even rarer events (BOEM 2017b). From 1964 to 2010 there were 283 well control incidents, 61 of which resulted in crude or condensate spills (BOEM 2012a, 2017b). From 1971 to 2010, fewer than 50 well control incidents occurred. Excluding the volume from the DWH spill, the total spilled volume was less than 2,000 bbl of crude or condensate, with the largest of the 1971-2010 spills—other than the DWH event—being 350 bbl. The DWH event was the only VLOS to occur between 1971 and 2010 (BOEM 2012a, 2017b). During that same time period, more than 41,800 wells were drilled on the OCS and almost 16 Bbbl of oil were produced.

From 1971-2010, industry drilled 223 exploration wells in the Pacific OCS, 46 in the Atlantic OCS, 15,138 in the Gulf of Mexico OCS, and 84 in the Alaska OCS, for a total of 15,491 exploration wells. During this period, there were 77 well control incidents associated with exploration drilling. Of those 77 well control incidents, 14 (18 percent) resulted in oil spills ranging from 0.5 bbl to 200 bbl, for a total 354 bbl, excluding the estimated volume from the DWH spill. These statistics show that, while approximately 15,000 exploration wells were drilled, there were a total of 15 loss-of-well-control events that resulted in a spill of any size: 14 were small spills and one was a large spill (≥1,000 bbl) that resulted in a blowout. That one large/very large spill was the DWH (BOEM 2017b).

The risk of an unlikely or rare event, such as a loss of well control incident, is determined using the best available historical data. The 2012-2017 Five-Year Program Final PEIS (BOEM 2012a) provides a detailed discussion of the OCS well control incidents and risk factors that could contribute to a long duration LOWC event. Risk factors include geologic formation and hazards; water depth and hazards; geographic location (including water depth); well design and integrity; loss of well control prevention and intervention; scale and expansion; human error; containment capability; response capability; oil types and weathering/fate; and specific regional geographic considerations, including oceanography and meteorology (BOEM 2017b).

Quantifying the frequency of VLOSs from a loss of well control event is challenging as relatively few large oil spills that can serve as benchmarks have occurred on the OCS (Scarlett et al. 2011). Based on an analysis of this historic data from both the 1971-2010 (the modern regulatory era) and the 1964-1971 time frames, the frequency of a loss of well control occurring and resulting in a VLOS of different volumes was determined (BOEM 2016b). This analysis, which is set forth in the 2017-2022 Five-Year Program Final PEIS, was used to calculate the frequency (per well) of a spill exceeding 4,610,000 bbl, which is the VLOS volume assumed in the Liberty analysis (BOEM 2017b).

Increased oil and gas development in the U.S. Arctic has led to an increased risk of various forms of pollution to whale and seal habitat, including oil spills, other pollutants, and nontoxic waste (Muto et al. 2017).

Contaminants in Bowhead Whales, Ringed Seals, and Bearded Seals

Metals and hydrocarbons introduced into the marine environment from offshore exploratory drilling activities are not likely to enter the Beaufort Sea food webs in ecologically significant amounts. However, there is a growing body of scientific literature on concentrations of metals and organochlorine chemicals (e.g., pesticides and polychlorinated biphenyls [PCBs]) in tissues of higher trophic level marine species, such as marine mammals, in cold-water environments.

There is particular concern about mercury in Arctic marine mammal food webs (MacDonald 2005). Mercury concentrations in marine waters in much of the Arctic are higher than concentrations in temperate and tropical waters due in large part to deposition of metallic and inorganic mercury from long-range transport and deposition from the atmosphere (Outridge et al. 2008). However, there is no evidence that significant amounts of mercury are coming from oil operations around Prudhoe Bay (Snyder-Conn et al. 1997) or from offshore drilling operations (Neff 2010).

Bowhead Whale

Some environmental contaminants, such as chlorinated pesticides, are lipophilic and can be found in the blubber of marine mammals (Becker et al. 1995). Tissues collected from whales landed at Barrow in 1992 (Becker et al. 1995) indicated that bowhead whales had very low levels of mercury, PCBs, and chlorinated hydrocarbons, but they had elevated concentrations of cadmium in their liver and kidneys. Bratton et al. (1993) measured organic arsenic in the liver tissue of one bowhead whale and found that about 98 percent of the total arsenic was arsenobetaine. Arsenobetaine is a common substance in marine biological systems and is relatively non-toxic.

Bratton et al. (1993) looked at eight metals (arsenic, cadmium, copper, iron, mercury, lead, selenium, and zinc) in the kidneys, liver, muscle, blubber, and visceral fat from bowhead whales harvested from 1983 to 1990. They observed considerable variation in tissue metal concentration among the whales tested. Metal concentrations evaluated did not appear to increase over time. The metal levels observed in all tissues of the bowhead are similar to levels reported in the literature in other baleen whales. The bowhead whale has little metal contamination as compared to other arctic marine mammals, except for cadmium. Mossner and Ballschmiter (1997) reported that total levels of polychlorinated biphenyls and chlorinated pesticides in bowhead blubber from the North Pacific and Arctic Oceans were many times lower than those in beluga whales or northern fur seals. However, while total levels were low, the combined level of three isomers of the hexachlorocyclohexanes (chlorinated pesticides) was higher in the blubber tested from bowhead whales than from three marine mammal species sampled in the North Atlantic (pilot whale, common dolphin, and harbor seal). These results were believed to be due to the lower trophic level of the bowhead as compared to the other marine mammals tested.

Ringed and Bearded Seals

Contaminants research on ringed seals is extensive throughout the Arctic environment where ringed seals are an important part of the diet for coastal human communities. Pollutants such as organochlorine compounds and heavy metals have been found in all of the subspecies of ringed seal (with the exception of the Okhotsk ringed seal). The variety, sources, and transport mechanisms of contaminants vary across ringed seal ecosystems (Kelly et al. 2010).

Heavy metals such as mercury, cadmium, lead, selenium, arsenic, and nickel accumulate in ringed seal vital organs, including liver and kidneys, as well as in the central nervous system (Kelly et al. 2010). Gaden et al. (2009) suggested that during ice-free periods the seals eat more Arctic cod (and mercury). They also found that mercury levels increased with age for both sexes (Dehn et al. 2005, Gaden et al. 2009). Becker et al. (1995) reported ringed seals had higher levels of arsenic in Norton Sound (inlet in the Bering Sea) than ringed seals taken by residents of Point Hope, Point Lay, and Barrow. Arsenic levels in ringed seals from Norton Sound were quite high for marine mammals, which might reflect localized natural arsenic sources.

Research on contaminants in bearded seals is limited compared to the information for ringed seals. However, pollutants such as organochlorine compounds and heavy metals have been found in most bearded seal populations. Climate change has the potential to increase the transport of pollutant from lower latitudes to the Arctic (Tynan and Demaster 1997).

Vessel and Fisheries Interactions

The general seasonal pattern of vessel traffic in the Arctic is correlated with seasonal ice conditions, which results in the bulk of the traffic being concentrated within the months of July through October, and unaided navigation being limited to an even narrower time frame. However, this pattern appears to be rapidly changing, as ice-diminished conditions become more extensive during the summer months.

The number of unique vessels tracked via AIS in U.S. waters north of the Pribilof Islands increased from 120 in 2008 to 250 in 2012, an increase of 108 percent (ICCT 2015). This includes only the northern Bering Sea, the Bering Strait, Chukchi Sea and Beaufort Sea to the

Canadian border. The increase in vessel traffic on the outer continental shelf of the Chukchi Sea and the near-shore Prudhoe Bay from oil and gas exploration activity is particularly pronounced (ICCT 2015).

However, the number of vessels identified in this region in 2012 likely also reflects traffic associated with the offshore exploratory drilling program that was conducted by Shell on the OCS of the Chukchi Sea that year. A comparison of the geographic distribution of vessel track lines between 2011 and 2012 provides some insight into the changes in vessel traffic patterns that may occur as a result of such activities (Figure 29). Overall, in 2012 there was a shift toward more offshore traffic and there were also noticeable localized changes in vessel traffic concentration near Prudhoe Bay and in the vicinity of the drilling project in the Chukchi Sea (ICCT 2015).

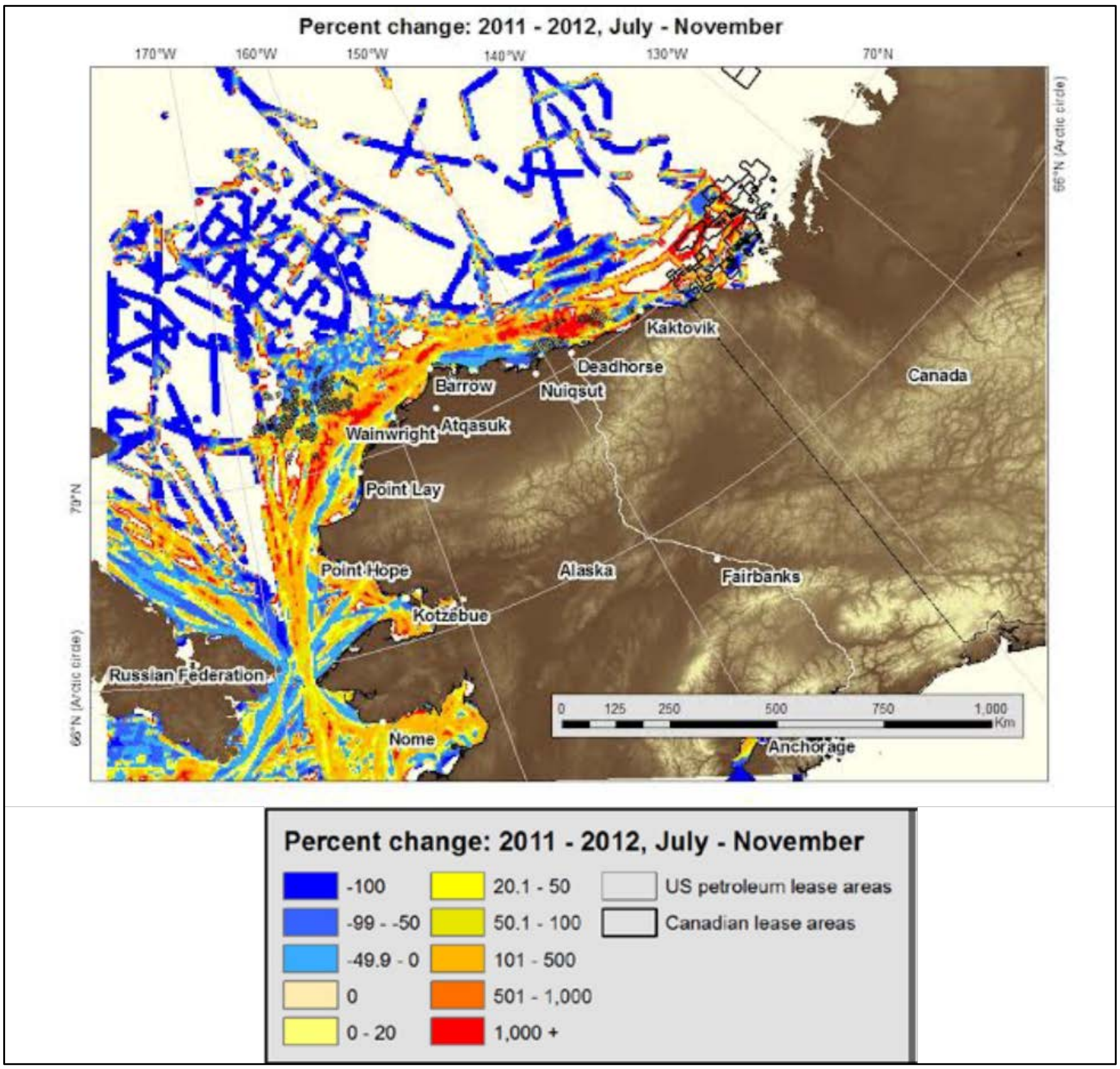


Figure 29. Percent difference in vessel activity between 2011 and 2012 using 5-km grid cells (ICCT 2015).

Vessel traffic can pose a threat to marine mammals primarily because of the risk of ship strikes, entanglement with vessel gear, and the potential disturbance from vessel noise.

5.1.2 Vessel Noise

Commercial shipping traffic is a major source of low frequency (5 to 500 Hz) human generated sound in the oceans (Simmonds and Hutchinson 1996, NRC (Nation Research Council) 2003). The types of vessels operating in the Bering, Chukchi, and Beaufort Seas typically include fishing vessels, barges, skiffs with outboard motors, icebreakers, scientific research vessels, and vessels associated with oil and gas exploration, development, and production. The primary underwater noise associated with vessel operations is the continuous noise produced from propellers and other on-board equipment. Cavitation noise is expected to dominate vessel acoustic output when tugs are pushing or towing barges or other vessels. Other noise sources include onboard diesel generators and the main engine, but both are subordinate to propeller harmonics (Gray and Greeley 1980). Shipping sounds are often at source levels of 150 to 190 dB re 1 μPa at 1 m (BOEM 2011) with frequencies of 20 to 300 Hz (Greene and Moore 1995). Sound produced by smaller boats is typically at a higher frequency, around 300 Hz (Greene and Moore 1995). In shallow water, vessels more than 10 km (6.2 mi) away from a receiver generally contribute only to background-sound levels (Greene and Moore 1995). Broadband source levels for icebreaking operations are typically between 177 and 198 dB re 1 μPa at 1m (Greene and Moore 1995, Austin et al. 2015).

5.1.3 Ship Strikes and Gear Entanglement

Although there is no official reporting system for ship strikes, numerous incidents of vessel collisions with marine mammals have been documented in Alaska (NMFS 2010). Vessel types involved collisions with large whales in Alaska included cruise ships, recreational cruisers, whale watching catamarans, fishing vessels, and skiffs (Neilson et al. 2012).

Vessels transiting the marine environment have the potential to collide with, or strike, marine mammals (Laist et al. 2001, Jensen and Silber 2003). From 1978 to 2012, there were at least 108 recorded whale-vessel collisions in Alaska, with the majority occurring in Southeast Alaska (Neilson et al. 2012; see Figure 12). Among larger whales, humpback whales are the most frequently documented victims of ship strikes in Alaska, accounting for 86 percent of all reported collisions. Fin whales accounted for 2.8 percent of reported collisions, gray whales 0.9 percent, and sperm whale 0.9 percent. Six of the whales (5.6 percent) were unidentifiable, and the remaining strikes are of non-listed species. There has only been one strike of an unidentified whale in the Bering Sea, and no strikes reported in the Chukchi and Beaufort Seas.

Bowhead Whales

Although records of ship collisions with bowhead whales are rare, bowheads are among the slowest moving of whales, which may make them particularly susceptible to ship strikes (Laist et al. 2001, George et al. 2017). George et al. (2017) analyzed scarring data for bowhead whales harvested between 1990 and 2012 to estimate the frequency of line entanglement, ship strikes, and killer-whale inflicted injuries. Only 10 of 504 whales harvested between 1990 and 2012 (~2 percent) showed clear evidence of scarring from ship propeller injuries, which the authors discussed may reflect some combination of the relatively low level of vessel traffic in the Pacific Arctic, a higher rate of mortality versus injury from ship strikes, and other unknown factors. For example, it may also reflect bowhead whale avoidance of interactions with ships. Approximately 12 percent of the harvested whales examined for signs of entanglement (59/486) had scar patterns that were identified with high confidence as entanglement injuries (29 whales with possible entanglement scars were excluded). Most of the entanglement scars occurred on the peduncle, and entanglement scars were rare on smaller subadult and juvenile whales (body length <10 m). The authors suspected the entanglement scars were largely the result of interactions with derelict fishing/crab gear in the Bering Sea. The estimate of 12 percent entanglement does not include bowheads that may have died as a result of entanglement.

There are no observer program records of bowhead whale mortality incidental to U.S. commercial fisheries in Alaska. However, in early July 2010 a dead bowhead whale was found floating in Kotzebue Sound entangled in crab pot gear similar to that used by commercial crabbers in the Bering Sea (Suydam et al. 2011); and during the 2011 spring aerial photographic survey of bowhead whales near Point Barrow, an entangled bowhead whale was photographed that was not considered to be seriously injured (Mocklin et al. 2012). Citta et al. (2014) found that the distribution of satellite-tagged bowhead whales in the Bering Sea overlapped spatially and temporally with areas where commercial pot fisheries occurred and noted the potential risk of entanglement in lost gear. The minimum estimated average annual mortality and serious injury rate in U.S. commercial fisheries in 2010 through 2014 is 0.2 bowhead whales; however, the actual rate is currently unknown.

Ringed and Bearded Seals

Current shipping activities in the Arctic pose varying levels of threats to ringed and bearded seals depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with their habitats. The presence and movements of ships in the vicinity of seals can affect their normal behavior (Jansen et al. 2010) and may cause them to abandon their preferred breeding habitats in areas with high traffic (Smiley and Milne 1979, Mansfield 1983). To date, no bearded or ringed seal carcasses have been found with propeller marks. However, Sternfeld (2004) documented a singled spotted seal stranding in Bristol Bay, Alaska that may have resulted from a propeller strike. Icebreakers pose greater risks to ringed and bearded seals because they are capable of operating year-round in all but the heaviest ice conditions and are often used to escort other types of vessels (e.g., tankers and bulk carriers) through ice-covered areas. Reeves (1998) noted that some ringed seals have been killed by ice-breakers moving through fast-ice breeding areas.

While no commercial fishing is currently authorized in the Beaufort Sea, ringed and bearded seals may be impacted by commercial fishing interactions as they migrate through the Bering Sea to the Chukchi Sea. Commercial fisheries may impact ringed and bearded seals through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations. Estimates of ringed and bearded seal bycatch could only be found for commercial fisheries that operate in Alaska waters. From 2012 through 2016, incidental mortality and serious injury of ringed seals was reported in 4 of the 22 federally-regulated commercial fisheries in Alaska monitored for incidental mortality and serious injury by fisheries observers: the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod trawl, and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Muto et al. 2017). Based on data from 2012 through 2016, the average annual rate of mortality and serious injury incidental to U.S. commercial fishing operations is 1.4 ringed seals.

From 2012 through 2016, incidental mortality and serious injury of bearded seals occurred in three fisheries: the Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands flatfish trawl, and Bering Sea/Aleutian Islands Pacific cod trawl fisheries (Muto et al. 2017). The estimated minimum mean annual mortality and serious injury rate incidental to U.S. commercial fisheries is 1.6 bearded seals, based exclusively on observer data.

Research

The NMFS Permits Division issues scientific research permits, for activities that adversely affect bowhead whales, ringed seals, and bearded seals in the Bering, Chukchi, and Beaufort Seas. The following summarizes current research permits issued, and more information can be found on the NMFS Authorizations and Permits for Protected Species website.

Permit No. 19309, which expired March 25, 2012, authorized the capture of up to 150 ringed seals and 150 bearded seals; takes by harassment of up to 3,000 of each species during capture operations and certain sampling activities; and takes by harassment of up to 3,200 bearded seals and 6,700 ringed seals during aerial surveys. Permit No. 20466, which expired March 31, 2012, authorized the capture of up to 200 bearded seals and 200 ringed seals; takes by harassment of up to 3,000 of each species during capture activities; and takes by harassment of up to 15,000 of each species during aerial and vessel surveys. Permit No. 18890, which expires June 15, 2021, authorizes the tagging and biopsy sampling of up to 120 bowhead whales in addition to biopsy sampling (only) of up to 50 bowhead whales; and up to 300 takes of bowhead whales by harassment during these activities. This permit also authorizes the annual capture of 2 bearded seals and 2 ringed seals; and take by harassment of up to 8 of each species during vessel surveys. Permit No. 14856, which expires December 31, 2018, authorizes the tagging and biopsy of up to 150 bowhead whales and take by harassment of up to 1,000 bowhead whales during vessel surveys. This permit also authorizes take by harassment of up to 100 ringed and 100 bearded seals during vessel surveys. Finally, Permit No. 20465, which expires May 31, 2022, authorizes take by harassment of up to 200 bearded seals and 200 ringed seals during aerial surveys. This permit also authorizes take by harassment of up to 11,000 bowhead whales during aerial surveys; tagging and biopsy sampling of up to 105 bowhead whales; and take by harassment of up to 100 bowhead whales during vessel surveys.

Occasionally, mortalities may occur incidental to marine mammal research activities authorized under MMPA research permits. In 2007 through 2011, one mortality was reported incidental to research activities on the Alaska stock of bearded seals, resulting in an average of 0.2 mortalities per year from this stock (Allen and Angliss 2014). In 2010 through 2014, one mortality was reported incidental to research on the Alaska stock of ringed seals, resulting in an average of 0.2 ringed seal mortalities per year from this stock (Muto et al. 2017).

Climate Change

"The Arctic marine environment has shown changes over the past several decades, and these changes are part of a broader global warming that exceeds the range of natural variability over the past 1,000 years" (Walsh 2008). The changes have been sufficiently large in some areas of the Arctic such that consequences on marine ecosystems appear to be ongoing (Walsh 2008). The proximate effects of climate change in the Arctic are being manifested as increased average winter and spring temperatures and changes in precipitation amount, timing, and type (Serreze et al. 2000). There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. In general, the sea-ice extent and thickness is decreasing in the Arctic summer and in winter. The distribution of ice is changing, and its age is decreasing. The melt duration is increasing. These factors lead to a decreasing perennial Arctic ice pack.

It is generally thought that the Arctic will become ice free in summer, but at this time there is considerable uncertainty about when that will happen. Parry (2007) predicted, by taking the mean of several climate models, that the Arctic will be ice free during summer in the latter part of the 21st century (Parry 2007). Holland et al. (2006) estimates that 40 to 60 percent summer ice loss will occur by the middle of the 21st century (Holland et al. 2006). Using a suite of models, Overland and Wang (2007) predicted a 40 percent or more ice loss for the Beaufort and Chukchi Seas by 2050. While the annual minimum sea ice extent is often taken as an index of the state of Arctic sea ice, the recent reductions of multi-year sea ice and sea ice thickness are of greater physical importance. It would take many years to restore the ice thickness through annual growth, and the loss of multi-year sea ice makes it unlikely that the Arctic will return to previous climatological conditions in the foreseeable future.

Increasing ocean acidification is predicted to cause changes in ecosystem processes and present additional stressors to organisms in the Arctic (BOEM 2015). Ocean acidification occurs as carbon dioxide increases in the atmosphere and is absorbed into ocean waters. The increase in carbon dioxide lowers pH over time and reduces the concentration of calcium carbonate in the sea (BOEM 2015). Mathis and Questel (2013) studied the carbonate chemistry in the northeast Chukchi Sea during August, September, and October 2010 and found low saturation rates of calcite and aragonite (two forms of calcium carbonate) as summer progressed.

Changes in sea ice and ocean acidification are expected to result in changes to the biological environment, causing shifts, expansion, or retraction of species' home ranges, changes in behavior, and changes in population parameters of species. Research in recent years has focused on the effects of naturally-occurring or man-induced global climate regime shifts and the potential for these shifts to cause changes in habitat structure over large areas. Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA 2005). These threats will be most pronounced for ice-obligate species such as the polar bear, walrus, ringed seal, and bearded seal.

The main concern about the conservation status of ringed and bearded seals stems from the likelihood that their sea ice habitat has been modified by the warming climate and, more so, that the scientific consensus projects accelerated warming in the foreseeable future. A second concern, related by the common driver of carbon dioxide emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem (75 FR 77496, 77502; December 10, 2010). According to climate model projections, snow cover is forecasted to be inadequate for the formation and occupation of birth lairs for ringed seals within this century over the Alaska stock's entire range (Kelly et al. 2010). A decrease in the availability of suitable sea ice conditions may not only lead to high mortality of ringed seal pups but may also produce behavioral changes in seal populations (Loeng et al. 2005). Changes in snowfall over the 21st century were projected to reduce areas with suitable snow depths for ringed seal lairs by 70 percent (Hezel et al. 2012).

The ringed seal's broad distribution, ability to undertake long movements, diverse diet, and association with widely varying ice conditions suggest they may be somewhat resilient in the face of environmental variability. Bearded seals, on the other hand, are restricted to areas where seasonal sea ice occurs over relatively shallow waters where they are able to forage on the bottom (Fedoseev 2000), and although bearded seals usually associate with sea ice, young seals may be found in ice-free areas such as bays and estuaries. Although no scientific studies have directly addressed the impacts of ocean acidification on ringed or bearded seals, the effects would likely be through their ability to find food. The decreased availability or loss of prey species from the ecosystem may have a cascading tropic effects on these species (Kelly et al. 2010).

However, not all Arctic species are likely to be adversely influenced by global climate change. Conceptual models suggested that overall reductions in sea ice cover should increase the Western Arctic stock of bowhead whale prey availability (Moore and Laidre 2006). This theory may be substantiated by the steady increase in the Western Arctic bowhead population during the nearly 20 years of sea ice reductions (Walsh 2008). Bowhead whales are dependent on sea-ice organisms for feeding and polynyas for breathing, so the early melting of sea ice may lead to an increasing mismatch in the timing of these sea-ice organisms and secondary production (Loeng et al. 2005). George et al. (2006), showed that harvested bowheads had better body condition during years of light ice cover. Similarly, George et al. (2015) found an overall improvement in bowhead whale body condition and a positive correlation between body condition and summer sea ice loss over the last 2.5 decades in the Pacific Arctic. George et al. (2015) speculated that sea ice loss has positive effects on secondary trophic production within the Western Arctic bowhead whale's summer feeding region. Moore and Huntington (2008) anticipated that bowhead whales will alter migration routes and occupy new feeding areas in response to climate related environmental change. Shelden et al. (2003) noted that there is a high probability that bowhead abundance will increase under a warming global climate.

There have recently been increases of subarctic species seasonally found in the Chukchi Sea. With increasing sea-surface temperatures in the Arctic, the potential northward movement of non-native species increases (Nordon 2014).

6 EFFECTS OF THE ACTION

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

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

We organize our effects analysis using a stressor identification – exposure – response – risk assessment framework for the proposed 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 action poses to endangered and threatened species.

Project Stressors

During the course of this consultation, we identified the following potential stressors from the proposed Liberty Project:

- Acoustic disturbance from activities associated with LDPI construction and operation;
- Direct injury, mortality, or harassment from on-ice activities;
- Habitat alteration from the placement of the LDPI;
- Pollution from unauthorized spills associated with vessel activities and LPDI construction and operations;
- Visual disturbance from vessels and project activities;
- Vessel strikes; and
- Entanglement and ingestion of trash and debris.

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 (bowhead whales, ringed seals, and bearded seals).

Exposure and Response Analyses

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.

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. While BOEM/BSEE did not provide a quantitative exposure analysis, Hilcorp provided a five-year analysis association with its LOA application. Based on these initial qualitative and quantitative analyses, NMFS AKR conducted its own analysis to estimate the number of exposures to listed resources that may result from stressors produced by the proposed action for the full 25-year duration of the proposed action.

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 whales and seals to project activities in this analysis are:

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

Threshold Shifts

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.

Auditory Interference (masking)

Auditory interference, or masking, occurs when an interfering noise is similar in frequency and loudness to (or louder than) the auditory signal received by an animal while it is processing echolocation signals or listening for acoustic information from other animals (Francis and Barber 2013). Masking can interfere with an animal’s ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Francis and Barber 2013).

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, Southall et al. 2003) and bottlenose dolphins

(Johnson 1967). These studies provide baseline information from which the probability of masking can be estimated.

Clark et al. (2009a) 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 (a baleen whale like blue, fin, sei, and humpback whales) 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 ancient 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).

In the presence of low frequency active sonar, humpback whales have been observed to increase the length of their songs (Miller et al. 2000, Fristrup et al. 2003), possibly due to the overlap in frequencies between the whale song and the low frequency active sonar. North Atlantic right whales have been observed to increase the frequency and amplitude (intensity) (Parks 2009) of their calls while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al. 2007). In contrast, both sperm and pilot whales potentially ceased sound production during experimental sound exposure (Bowles et al. 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Phocids (ringed and bearded seals) and bowhead whales have good low-frequency hearing; thus, it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds, such as those from vessel noise or pile driving (Gordon et al. 2003).

Evidence suggests that at least some marine mammals have the ability to acoustically identify predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al. 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. Auditory masking may prevent marine mammals from responding to the acoustic cues produced by their predators. The effects of auditory masking on the predator-prey relationship depends on the duration of the masking and the likelihood of encountering a predator during the time that predator cues are impeded.

Liberty oil and gas activities in the Beaufort 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 being 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. (1995c). More recent reviews (e.g., Ellison et al. 2012; Nowacek et al. 2007; Southall et al. 2009; Southall et al. 2007a) address studies conducted since 1995 and 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.

Baleen whales have shown a variety of responses to impulsive sound sources, including avoidance, reduced surface intervals, altered swimming behavior, and changes in vocalization rates (Richardson et al. 1995c, Southall et al. 2007). While most bowhead whales did not show active avoidance until within 8 km of seismic vessels (Richardson et al. 1995b), some whales avoided vessels by more than 20 km at received levels as low as 120 dB re 1 μPa root mean square (rms). Additionally, Malme et al. (1988) observed clear changes in diving and respiration patterns in bowheads at ranges up to 73 km from seismic vessels, with received levels as low as 125 dB re 1 μPa.

Bowhead reaction to drillship-operation noise is variable. Richardson and Malme (1993) point out that the data, although limited, suggest that stationary industrial activities producing continuous noise, such as stationary drillships, result in less dramatic reactions by whales than do moving sources, particularly ships. Several authors noted that migrating whales are likely to avoid stationary sound sources by deflecting their course slightly as they approached a source (Richardson et al. 1995c). McDonald et al. (2006b) reported subtle offshore displacement of the southern edge of the bowhead whale migratory corridor offshore from the drilling on Northstar island. Some bowheads likely avoid closely approaching drilling operations by changing their migration speed and direction, making distances at which reactions to drillships occur difficult to determine. LGL and Greenridge (1987) and Schick and Urban (2000) indicate that few whales approached within ~18 km of an offshore drilling operation in the Beaufort Sea. Results in Schick and Urban (2000) indicated that whales within hearing range of the drillship (<50 km [<31.1 mi]) were distributed farther from the rig than they would be under a random scenario.

Although bowheads have been observed well within the ensonified zones around active drill ships, playbacks of drillship noise to a small number of bowheads demonstrated some avoidance. Playbacks of *Explorer II* drillship noise (excluding components below 50 Hz) showed that some bowheads reacted to broadband received levels near 94-118 dB re 1 µPa – no higher than the levels tolerated by bowheads seen a few kilometers from actual drillships (Richardson et al. 1985, Richardson et al. 1990). The playback results of Wartzok et al. (1989) seem consistent: the one observed case of strong avoidance of *Kulluk* drilling noise was at a broadband received level ≥ 120 dB.

Two explanations may account for the seemingly different reactions of summering bowhead to playbacks versus actual drilling: tolerance and variable sensitivity. Bowheads may react to the onset of industrial noise (over several minutes) during a brief playback, but show tolerance when that sound level continues for a long period near an actual drillship. However, playback also showed that responsiveness varies among individuals and days. Thus, whales near actual drillships may have been some of the less responsive individuals, meaning, those remaining after the more responsive animals had moved out of the area. Both tolerance and variable sensitivity may have been involved (Richardson et al. 1995c).

If bowhead whales avoid drilling and related support activities at distances of approximately 20 km (consistent with avoidance distances presented in (Koski and Johnson 1987, LGL and Greenridge 1987, Schick and Urban 2000)), this would preclude prolonged exposure of the vast majority of individuals to continuous sounds ≥120 dB re 1 µPa rms associated with this project.

A review of behavioral reactions by pinnipeds to impulsive noise can be found in Richardson et al. (1995a) and Southall (2007). Blackwell et al. (2004a) observed that ringed seals exhibited little or no reaction to drilling noise with mean underwater levels of 157 dB re 1 µPa rms and in air levels of 112 dB re 20 µPa, suggesting the seals had habituated to the noise. In contrast, captive California sea lions avoided sounds from an impulsive source at levels of 165 to 170 dB re 1 µPa (Finneran et al. 2003).

Experimentally, Götz and Janik (2011) tested underwater responses to a startling sound (sound with a rapid rise time and a 93 dB sensation level [the level above the animal's threshold at that frequency]) and a non-startling sound (sound with the same level, but with a slower rise time) in wild-captured gray seals. The animals exposed to the startling treatment avoided a known food source, whereas animals exposed to the non-startling treatment did not react or habituate during the exposure period. The results of this study highlight the importance of the characteristics of the acoustic signal in an animal's habituation.

In cases where whale or seal response is brief (i.e., changing from one behavior to another, relocating a short distance, or ceasing vocalization), effects are not likely to be significant at the population level, but could rise to the level of take of individuals.

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 (Bain 2002, Erbe 2002b, Williams and Ashe 2006, Noren et al. 2009, Williams and Noren 2009, Pirotta et al. 2015). In an analysis of energy costs to killer whales, Williams et al. (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 seals 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 (NMFS 2006). Therefore, exposure to levels sufficient to trigger onset of PTS or TTS are expected to be accompanied by physiological stress responses (NRC 2003, NMFS 2006).

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 seals may experience stress responses. If whale and seals 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.

6.1.1 Major Noise Sources

As discussed in Section 2, *Description of the Proposed Action*, BOEM/BSEE intend to authorize a wide variety of acoustic activities within the action area (see Table 16).

6.1.1.1 Acoustic Thresholds

Since 1997, NMFS has used generic sound exposure thresholds to determine whether an activity produces underwater sounds that might result in impacts to marine mammals (70 FR 1871, 1872; January 11, 2005). NMFS recently revised the comprehensive guidance on sound levels likely to cause injury to marine mammals through onset of permanent and temporary threshold 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[12], expressed in rms[13] from broadband sounds that cause behavioral disturbance, and referred to as Level B harassment under section 3(18)(A)(ii) of the MMPA:

- impulsive sound: 160 dB re 1 μPa_{rms}
- continuous 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 2018b). Different thresholds and auditory weighting functions are provided for different marine mammal hearing groups, which are defined in the Technical Guidance (NMFS 2018b). The generalized hearing range for each hearing group is in Table 14.

[12] 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.

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

Table 14. Underwater marine mammal hearing groups (NMFS 2018b).

Hearing Group	ESA-listed Marine Mammals In the Project Area	Generalized Hearing Range[1]
Low-frequency (LF) cetaceans *(Baleen whales)*	Bowhead whales	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans *(dolphins, toothed whales, beaked whales)*	None	150 Hz to 160 kHz
High-frequency (HF) cetaceans *(true porpoises)*	None	275 Hz to 160 kHz
Phocid pinnipeds (PW) *(true seals)*	Ringed and bearded seals	50 Hz to 86 kHz
Otariid pinnipeds (OW) *(sea lions and fur seals)*	None	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 a 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. 2007) and PW pinniped (approximation).

The PTS onset acoustic thresholds are presented in Table 15, 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.

Level A harassment radii can be calculated using the optional user spreadsheet[14] associated with NMFS Acoustic Guidance, or through modeling.

[14] 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 2018b).

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.

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

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

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

While the ESA does not define "harass," NMFS recently issued guidance interpreting the term "harass" under the ESA 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).

6.1.1.2 Noise Activity Description

SLR Consulting (2017) developed a list of the Liberty Project's construction and operational activities and their associated equipment with the potential for noise impacts to marine mammals. Source levels and spectra (indicating the source noise contribution at each frequency) for each noise source and stressor were determined based on a literature review of the best available science (Table 17).

Table 16. Noise assessment stressors, noise source, and location (SLR Consulting 2017)

Season	Activity	Noise Source	Source Locations
Ice-Covered	Ice road/trail construction and maintenance	Grader/snow removal equipment Ice auger Water pump trucks	Ice roads
	Pipeline Construction	Trucks on ice road Backhoe digging Ditchwitch sawing ice	Ice roads along pipeline route
	General Island Construction	Trucks on ice road Backhoe digging Ditchwitch sawing ice	Island location
	Vibratory sheet pile driving	Vibratory pile driver	Island edge
	Impact sheet pile driving	Impact pile driver	Island edge
	Conductor pipe impact driving	Impact pile driver	Island interior
	Emergency and oil spill response training	Grader/snow removal equipment Bobcat loader Ice auger Generators/light plants Snowmachine All-terrain vehicle ARKTOS	Island and vicinity
	Helicopter transportation	Helicopter	Island and vessel route
	Drilling and Production	Drilling and production equipment	Island interior
	Production only	Production equipment	Island interior
Open-water	Slope shaping, armament installation	Heavy equipment-e.g. excavator, dump trucks, backhoes	Island edge
	Vibratory sheet pile driving	Vibratory pile driver	Island edge
	Impact sheet pile driving	Impact pile driver	Island edge
	Conductor pipe driving	Impact pile driver	Island interior
	Emergency and oil spill response training	Vessels-e.g. Zodiacs, Kiwi Noreens, Bay-class boats	Island and vicinity
	Vessel Transportation	Seagoing Barges and tugs Coastal Barges and tugs Small crew boats	Island and vessel route
	Hovercraft transportation	Griffin 2000 TD	Vessel route
	Helicopter transportation	Helicopter	Island and vessel route
	Drilling and Production	Drilling and Production	Island interior
	Production only	Production equipment	Island interior

6.1.1.3 Acoustic Modeling

Full details of the source noise levels, references, and spectra used to model noise propagation in-air, in-water, and under ice are provided in the Hilcorp Liberty Project Underwater and Airborne Noise Modelling Report developed by SLR Consulting (Appendix A). The analysis relies heavily on historical noise measurements from the Northstar development and production island (SLR Consulting 2017). Northstar is located west of the action area and is 9.5 km from the mainland on a manmade gravel island in 12 m of water. Construction methods proposed for the

Liberty gravel island are similar to methods used to build the Northstar island. At Liberty, noise generated may be different depending on the equipment used, substrate conditions, and sound propagation factors. The noise sources are approximated as either points or lines for modelling purposes. For example, sources located at the Liberty island are modelled as a single stationary point, whereas sources associated with ice road construction are represented as a line along the route. The underwater noise generated by vessel movements has been modelled at several points along the linear route, with the resulting predictions extrapolated along the line (SLR Consulting 2017).

While activities such as emergency and oil spill response training may occur in various locations in the vicinity of the island, the noise generated by these activities would extend over a similar area regardless of the precise location of the activity. Therefore, the approximation of a single point source at the island for these types of scenarios is appropriate in determining the potential area within which disturbance of marine mammals may occur (SLR Consulting 2017).

The modeling considers the generation and propagation of underwater noise in both summer (open-water) and in winter (ice-covered) conditions as well as in-air noise. SLR Consulting (2017) took the following approaches for each one of these environmental conditions:

- **Open-water Season:** Measured open water noise data from Northstar Island is available for the drilling and production scenario, and also for vessel noise (Blackwell and Greene 2006). However, open-water measured noise propagation data is not available for all activities proposed during the open-water season for the Liberty Project. For example, sheet piling and noise monitoring was undertaken during construction of Northstar during the ice-covered season, but this activity did not occur or was not monitored after ice break-up. Therefore, an alternative numerical and frequency dependent modelling approach to underwater noise propagation prediction was utilized, which does not solely rely on reported broadband propagation relationships from Northstar.

  In addition to the lack of comprehensive open water measurement data from Northstar, there are two additional reasons to undertake more detailed numerical noise modelling of the open water scenarios for Liberty. First, the LDPI is located in around 6 m (19 ft) of water, which is considerably shallower than Northstar Island at around 12 m (39 ft). For this reason there are expected to be differences in open-water noise propagation and attenuation between the two sites. In particular, lower frequency underwater sound (below about 80 to 150 Hz) within the Liberty project area is expected to have higher attenuation than Northstar, due to the shallower water environment for Liberty. Second, the LDPI is located within the barrier islands, and whale migration routes lie almost entirely to the north of the barrier islands. A more detailed numerical model is able to consider the “shielding” effect of the barrier islands on underwater noise (SLR Consulting 2017).

  The noise modeling approach for the open-water season enables prediction of noise propagation over longer distances, accounting to some degree for site specific bathymetry and sea-floor characteristics. This frequency dependent approach also enables a review of the potential for PTS, by weighting the received noise level with consideration of the hearing sensitivity of the various species of interest. The detailed noise model predictions have been compared with empirical data from Northstar and also to a practical spreading loss model, as a check on the validity of the detailed model results (SLR Consulting

2017).

- **Ice-covered Season**: For underwater noise in the ice-covered season, an empirical approach was used to determine noise propagation, based on measurements undertaken during comparable activities during construction of the Northstar Island. This approach is able to identify the extent of noise levels above NMFS current marine mammal behavioral disturbance thresholds based on overall unweighted noise levels. PTS impacts during the ice-covered season are anticipated to be negligible with reduced noise propagation under ice relative to the open-water season (SLR Consulting 2017).

- **In-air Noise:** For in-air noise, commercial noise modeling software has been used to identify noise propagation and the extent of potential disturbance of marine mammals.

Details on the execution and inputs used in the modeling of noise propagation in-air, in-water, and under ice are provided in the Underwater and Airborne noise modelling report (Appendix A; SLR Consulting 2017). Table 17 summarizes the sound source levels for each stressor depending on the environmental condition (open-water, ice-covered, in-air) and the predicted Level B thresholds.

Table 17. Summary of stressors, associated sound source levels, and calculated distances to Level A and B.

Stressor	Underwater Noise (Ice-Covered)			Underwater Noise (Open Water)					Airborne Noise		
	Level B			Level B			Level A		Level B		
	Average SPL (dB re1μPA at 1 m)	Distance to Threshold (km)	Ensonified Area (km^2)	Received Level (RMS) (dB re 1μPA at 1m)	Distance to Threshold (km)	Ensonified Area (km^2)	Distance to Threshold (km)	Ensonified Area (km^2)	Source Sound Pressure Level at Distance (dB re 20μPA)	Distance to Threshold (km)	Ensonified Area (km^2)
Ice Road Construction and Maintenance[1]	189.1	0.17 (558 ft)	0.09 (22 ac)	n/a	n/a	n/a	n/a	n/a	Graders 64.7 at 100 m Augers 67.9 at 100 m Water pumps 72 at 100 m	< 0.02 (66 ft)	0.001 (0.03 ac)
Island and Pipeline Construction[1]	Trucks on ice road - 179.1 Backhoe - 177.7 Ditchwitch - 169.6	0.21 (689 ft)	0.14 (35 ac)	n/a	n/a	n/a	n/a	n/a	Trucks on ice road 74.8 at 100 m Backhoe 78 at 10 m Ditchwitch 76.3 at 100 m	< 0.02 (66 ft)	0.001 (0.03 ac)
Vibratory Sheet Pile Driving[1]	221.0	0.39 (1,280 ft)	0.48 (119 ac)	185	14.8 (48,556 ft)	North–264 (65,000 ac) East–229 (57,000 ac) South–102 (25,000 ac) West–109 (27,000 ac) SW–64 16,000(ac)[3]	LF: 0.05 (164 ft) PW: 0.02 (66 ft)	LF: 0.007 (1.7 ac) PW: 0.001 (0.24 ac)	81 at 100 m	0.02 (66 ft)	0.001 (0.03 ac)
Impact sheet pile driving[2]	235.7	0.09 (295 ft)	0.03 (7.4 ac)	210	2.05 (8,202 ft)	19.6 (4,843 ac)	LF: 1.94 (6,365 ft) PW: 0.53 (1,706 ft)	LF: 11.8 (2,916 ac) PW: 0.87 (215 ac)	93 at 160 m	0.1 (328 ft)	0.031 (7.4 ac)
Slope shaping, armament installation[1]	n/a	n/a	n/a	167	1.16 (3,806 ft)	4.2 (1,038 ac)	LF: <0.01 (33 ft) PW: <0.01 (33 ft)	LF: <0.001 PW: <0.001	64.7 at 100 m	< 0.02 (66 ft)	0.001 (0.03 ac)
Conductor pipe impact driving[2]	171.7	0.01 (36 ft)	<0.01 (<2.5 ac)	196	0.31 (1,017 ft)	0.3 (74 ac)	LF: 0.87 (2,854 ft) PW: 0.24 (787 ft)	LF: 2.38 (588 ac) PW: 0.18 (45 ac)	93 at 160 m	0.1 (328 ft)	0.031 (7.4 ac)
Emergency spill response training[1]	189.1	0.17 (558 ft)	0.09 (22 ac)	156	0.225 (738 ft)	0.16 (40 ac)	n/a	n/a	62 at 300 m	< 0.02 (66 ft)	0.001 (0.03 ac)
Helicopter[1] (take-off, landing)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	84 at 300 m	0.07 (230 ft)	0.014 (3.6 ac)
Vessel transportation[1]	n/a	n/a	n/a	170	1.85 (6,070 ft)	10.75 (2,656 ac)	n/a	n/a	62 at 300 m	< 0.02 (66 ft)	0.001 (0.03 ac)
Hovercraft[1]	n/a	n/a	n/a	149	0.07 (230 ft)	0.02 (5 ac)	n/a	n/a	104 at 6.5 m	0.02 (66 ft)	0.001 (0.03 ac)
Drilling and production[1]	170.5	0.23 (755 ft)	0.17 (42 ac)	151	0.06 (197 ft)	0.01 (2.5 ac)	n/a	n/a	80 at 200 m	0.03 (98 ft)	0.003 (0.7 ac)
Production Only[1]	154.5	0.04 (131 ft)	0.01 (2.5 ac)	153	0.05 (164 ft)	0.01 (2.5 acre)	n/a	n/a	80 at 200 m	0.03 (98 ft)	0.003 (0.7 ac)

Source: (SLR Consulting 2017, Hilcorp 2018a)

[1]Continuous sounds or non-impulsive sounds have a threshold of 120 dB_{rms} re 1μPa for Level B Harassment.

[2]Impulsive sounds have a threshold of 160 dB_{rms} re 1μPa for Level B Harassment

[3]Since vibratory sheet piling will occur near the periphery of the constructed island, the area ensonified will depend on the side of the island where vibratory sheet piling is occurring.

6.1.1.4 ESA-listed Species Exposure Estimates

Density

It is not possible to estimate the number of individuals by age or gender that maybe affected by the project; however, there is density information available on the number of individuals across all age classes and gender for each ESA-listed species. During this consultation, we reviewed the densities Hilcorp used in its LOA application (Hilcorp 2018a) and agree they constitute the best available scientific information. To determine the number of marine mammals expected to be exposed at any given time during the life of the project, densities by season were identified for each ESA-listed species. Table 18 summarizes densities for ESA-listed marine mammals used to calculate exposure estimates. The number of marine mammals exposed to behavioral harassment from the proposed action is calculated by multiplying these expected densities of marine mammals in the project area by the area ensonified and defined as Level B harassment (Section 6.1.1.1).

We have adopted the calculated exposures presented by Hilcorp in the Request for Incidental Take Authorization and the associated proposed rule (84 FR 24926; 84 FR 32697) for our exposure analysis for the first 5 years of the proposed project. Although there is limited information on how densities of ESA-listed species may change over time, and the fluctuations that could occur due to climate change or other environmental factors, we considered the current density estimates to be the best approximation of future densities, and used them determine potential exposure of ESA-listed species to the proposed action during years 6 through 25.

Table 18. Summary of the average seasonal densities of ESA-listed species found in the action area (SMRU Consulting 2017).

Season	Bowhead Whales (per km^2)	Ringed Seals (per km^2)	Bearded Seals (per km^2)
Winter (Nov - Mar)	0	0.55	0.003
Spring (Apr - Jun)	0	0.548	0.003
Summer (Jul - Aug)	0.005	0.27	0.05
Fall (Sept - Oct)	0.01	0.27	0.05
Note: The previous opinion (issued in July 2018) and SMRU Consulting 2017 report contained small errors for bowhead whale and ringed seal densities; they have been corrected in this opinion.			

Exposure estimates were calculated by multiplying the season-specific density estimates for each species (Table 18) expected to be present in Foggy Island Bay with the area ensonified to the Level B threshold by the activities expected to occur on a given day. Since multiple activities or stressors could occur in a given day, the noise source with the largest area of ensonification to the Level B threshold, also referred to as the dominant noise source, was used to calculate exposure. Table 19 outlines the assumed dominant noise source on any given day during the life of the project. Dominant noise sources and exposure estimates for years 1 through 5 correspond to take requested in the LOA application (Hilcorp 2018a). Since exposure estimates were calculated by season-specific densities for each species,

Table 20 outlines the number of days each dominant noise source is expected to occur by season. The number of days was then multiplied by the exposure estimate to that dominate noise source on any given day to determine the number of individuals expected to be exposed within a given year (Table 21).

Assumptions

NMFS AKR based the number and type of dominant noise sources during production and operation (years 6 through 23) and decommissioning (years 24 and 25) on information presented in the Biological Assessment, EIS, DPP, NMFS Permits Division proposed rule, and information gathered during the consultation process. The following are the assumptions NMFS made to determine the exposure estimates for years 6 through 23.

- Clarke et al. (2017) have documented group sizes of bowhead whales near the Liberty project area, seaward of the barrier islands, to typically range from 2 to 5 animals. Therefore, to conservatively account for groups of bowhead whales, if the estimate for exposure was less than 1 (i.e. in years 2 through 24), the exposure estimate was rounded up to 5.
- Hilcorp plans to drill the first 10 wells in years 1 through 5, with the potential to drill the remaining 6 wells in years 6 through 23 depending on the economic viability of the reservoir. Therefore, in years 6 through 23 marine mammals could be exposed to noise from production and operations and occasionally from drilling new wells or maintenance drilling. It takes 30 to 45 days to drill one well, resulting in up to 270 days of drilling over 17 years of production and operation activities. Maintenance drilling of existing wells would be approximately two nonconsecutive weeks per year. Therefore, for our exposure estimate in years 6 through 23, NMFS estimated 30 drilling days per year (270 days divided by 17 years plus 14 days of maintenance drilling per year) with 50 percent occurring during the open-water season and 50 percent during the ice covered season. Since it is unknown if these drilling activities will occur in the winter or spring during the ice-covered season and summer or fall during the open-water season, NMFS assumed that the activity would occur during times with the highest species densities (i.e., spring and fall; Table 18).
- Hilcorp has indicated that emergency oil spill response training will occur for up to 17 days per year during the ice-covered season and 7 days per year during the open-water season. Since it is unknown if these training activities during the ice-covered season will occur in the winter or spring and if these training activities during the open-water season will occur in the summer or fall, to be conservative NMFS assumed that the activity would occur during times with the highest species densities (i.e., spring and fall; Table 18).
- Decommissioning activities are expected to begin in year 24 and extend 18 months over two winter seasons. Island deconstruction will include the removal of surface facilities and pipeline clearing and plugging. Exposure estimates were calculated for general island deconstruction activities (including removal of surface facilities, pipeline clearing and plugging, etc.) and vibratory sheet pile removal. Island deconstruction activities in the winter and spring seasons are anticipated to use similar equipment that will be used during island construction; therefore, the level B threshold is anticipated to be the same.

With the exception of vibratory sheet pile removal, it is anticipated that there will be no other in-water work during the open-water season. Vibratory sheet pile removal is expected to occur only in year 25. With limited source level data available for vibratory pile extraction of sheet piles, NMFS used the same values for both vibratory installation and extraction assuming that the two activities would produce similar source levels and the equipment would remain consistent.

Table 19. Dominant noise source by month and days of each activity used to calculate exposure estimates (Hilcorp 2018a).

<table>
<tr><th>Season</th><th>Month</th><th>Year 1</th><th>Year 2</th><th>Year 3</th><th>Year 4</th><th>Year 5</th><th>Years 6 - 23</th><th>Year 24</th><th>Year 25</th></tr>
<tr><td rowspan="7">Ice-covered Season</td><td>Dec</td><td rowspan="2">Ice Road Construction (62 days)</td><td rowspan="2">Ice Road Construction (62 days)</td><td rowspan="7">Drilling and Production (212 days)</td><td rowspan="7">Drilling and Production (212 days)</td><td rowspan="7">Drilling and Production (212 days)</td><td>Ice Road Construction (31 days/year)</td><td rowspan="2">Ice Road Construction (62 days)</td><td rowspan="2">Ice Road Construction (62 days)</td></tr>
<tr><td>Jan</td><td rowspan="6">Drilling and Production (15 days/year)
Emergency Response Training (17 days/year)
Production Only (166 days/year)</td></tr>
<tr><td>Feb</td><td rowspan="3">Island Construction (89 days)</td><td rowspan="5">Facility Construction (150 days)</td><td rowspan="5">Island Deconstruction (150 days)</td><td rowspan="3">Island Deconstruction (89 days)</td></tr>
<tr><td>March</td></tr>
<tr><td>April</td></tr>
<tr><td>May</td><td>Island Construction (14 days)
Vibratory Sheet Pile Driving (17 days)</td><td>Island Deconstruction (14 days)
Vibratory Sheet Pile Removal (17 days)</td></tr>
<tr><td>June</td><td>Vibratory Sheet Pile Driving (30 days)</td><td>Vibratory Sheet Pile Removal (30 days)</td></tr>
<tr><td rowspan="4">Open-water Season</td><td>July</td><td>Vibratory Sheet Pile Driving (15 days)
Slope Shaping (16 days)</td><td>Foundation Piles Installation (31 days)</td><td rowspan="4">Drilling and Production (123 days)</td><td rowspan="4">Drilling and Production (123 days)</td><td rowspan="4">Production (123 days)</td><td rowspan="4">Drilling and Production (15 days/year)
Emergency Response Training (7 days/year)
Production Only (101 days/year)</td><td rowspan="4">Island Deconstruction (123 days)</td><td rowspan="4">Vibratory Sheet Pile Removal (15 days)
Island Deconstruction (108 days)</td></tr>
<tr><td>Aug</td><td>Slope Shaping (31 days)</td><td rowspan="3">Rig Mobilization & Well Prep (92 days)</td></tr>
<tr><td>Sept</td><td rowspan="2">Rig Mobilization & Well Prep (61 days)</td></tr>
<tr><td>Oct</td></tr>
<tr><td>Ice-covered Season</td><td>Nov</td><td>Rig Mobilization & Well Prep (30 days)</td><td>Drilling and Production (30 days)</td><td>Drilling and Production (30 days)</td><td>Drilling and Production (30 days)</td><td>Production (30 days)</td><td>Production (30 days)</td><td>Island Deconstruction (30 days)</td><td>Island Deconstruction (61 days)</td></tr>
</table>

Table 20. Number of days of dominant noise source by season for each activity used to calculate exposure estimates (Hilcorp 2018a).

Season	Year 1	Year 2	Year 3	Year 4	Year 5	Years 6 - 23	Year 24	Year 25
Winter (Nov – Mar)	Rig Mobilization & Well Prep (30 days) Ice Road Construction (62 days) Island Construction (59 days)	Drilling and Production (30 days) Ice Road Construction (62 days) Facility Construction (59 days)	Drilling and Production (151 days)	Drilling and Production (151 days)	Drilling and Production (121 days) Production Only (30 days)	Ice Road Construction (31 days/year) Production Only (120 days/year)	Island Deconstruction (89 days) Ice Road Construction (62 days)	Island Deconstruction (89 days) Ice Road Construction (62 days)
Spring (Apr – June)	Island Construction (44 days) Vibratory Sheet Pile Driving (47 days)	Facility Construction (91 days)	Drilling and Production (91 days)	Drilling and Production (91 days)	Drilling and Production (91 days)	Drilling and Production (15 days/year) Emergency Response Training (17 days/year) Production Only (59 days/year)	Island Deconstruction (91 days)	Island Deconstruction (44 days) Vibratory Sheet Pile Removal (47 days)
Summer (Jul-Aug)	Vibratory Sheet Pile Driving (15 days) Slope Shaping (47 days)	Foundation Pile Installation (31 days) Rig Mobilization & Well Prep (31 days)	Drilling and Production (62 days)	Drilling and Production (62 days)	Production Only (62 days)	Production Only (62 days/year)	Island Deconstruction (62 days)	Vibratory Sheet Pile Removal (15 days) Island Deconstruction (47 days)
Fall (Sept – Oct)	Rig Mobilization & Well Prep (61 days)	Rig Mobilization & Well Prep (61 days)	Drilling and Production (61 days)	Drilling and Production (61 days)	Production Only (61 days)	Drilling and Production (15 days/year) Emergency Response Training (7 days/year) Production Only (39 days/year)	Island Deconstruction (61 days)	Island Deconstruction (61 days)

Table 21. Level B exposure estimates for the life of the proposed action.

Season	Dominate Noise Source	Area of Level B Threshold (km^2)	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6 - 23				Year 24				Year 25			
			# of days of Stressor	Bowhead	Ringed	Bearded	# of days of Stressor	Bowhead	Ringed	Bearded	# of days of Stressor	Bowhead	Ringed	Bearded	# of days of Stressor	Bowhead	Ringed	Bearded	# of days of Stressor	Bowhead	Ringed	Bearded	# of days of Stressor	Bowhead	Ringed	Bearded	# of days of Stressor	Bowhead	Ringed	Bearded	# of days of Stressor	Bowhead	Ringed	Bearded
Winter	Ice Road Construction	0.09	62	0	3.1	0.02	62	0	3.07	0.02	0	0	0	0	0	0	0	0	0	0	0	0	31	0	1.4	0.008	62	0	2.8	0.02	62	0	2.8	0.02
	Island Construction	0.14	59	0	4.5	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Facility Construction	0	0	0	0	0	59	0	0	0																								
	Rig Mobilization & Well Prep	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Drilling and Production	0.17	0	0	0	0	30	0	2.8	0.02	151	0	14	0.08	151	0	14	0.08	121	0	11.3	0.06	0	0	0	0	0	0	0	0	0	0	0	0
	Production Only	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0.2	0.001	120	0	0.6	0.004	0	0	0	0	0	0	0	0
	Island Deconstruction	0.14[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89	0	6.4	0.04	89	0	6.4	0.04
Spring	Island Construction	0.14	44	0	3.4	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Vibratory Sheet Pile Driving or Removal	0.48	47	0	12	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	0	12	0.07
	Facility Construction	0	0	0	0	0	91	0	0	0	0	0	0	0																				
	Emergency Response Training	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0.8	0.005	0	0	0	0	0	0	0	0
	Drilling and Production	0.17	0	0	0	0	0	0	0	0	91	0	8.5	0.05	91	0	8.5	0.05	91	0	8.5	0.05	15	0	1.4	0.008	0	0	0	0	0	0	0	0
	Production Only	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	0	0.3	0.002	0	0	0	0	0	0	0	0
	Island Deconstruction	0.14[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	91	0	7	0.04	44	0	3.4	0.02
Summer	Vibratory Sheet Pile Driving or Removal	63.91	15	4.8	259	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	3.8	259	47.9
	Slope Shaping	4.23	47	1	54	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Foundation Pile Installation	0.31	0	0	0	0	31	0.05	2.6	0.5	0	0	0	0	0	0	0	0																
	Rig Mobilization & Well Prep	0	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0																
	Drilling and Production	0.009	0	0	0	0	0	0	0	0	62	0.003	0.2	0.03	62	0.003	0.2	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Production Only	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62	0.003	0.2	0.03	62	0.002	0.2	0.03	0	0	0	0	0	0	0	0
	Island Deconstruction	0[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0	47	0	0	0
Fall	Rig Mobilization & Well Prep	0	61	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Emergency Response Training	0.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0.01	0.3	0.06	0	0	0	0	0	0	0	0
	Drilling and Production	0.009	0	0	0	0	0	0	0	0	61	0.005	0.2	0.03	61	0.005	0.2	0.03	0	0	0	0	15	0.001	0.04	0.007	0	0	0	0	0	0	0	0
	Production Only	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0.006	0.2	0.03	39	0.004	0.1	0.02	0	0	0	0	0	0	0	0
	Island Deconstruction	0[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0	0	0	61	0	0	0
			Total Exposure	**5.8**	**336**	**58**	**Total Exposure**	**5[2]**	**8.5**	**0.5**	**Total Exposure**	**5[2]**	**23**	**0.2**	**Total Exposure**	**5[2]**	**23**	**0.18**	**Total Exposure**	**5[2]**	**20.2**	**0.17**	**Total Exposure Per Year**	**5[2]**	**5.2**	**0.139**	**Total Exposure**	**0**	**16**	**0.18**	**Total Exposure**	**3.8**	**16**	**0.18**

Note: Exposure numbers by stressors are rounded up or down, therefore, there may be minor differences between summing exposure estimate per year with the listed total exposure numbers.

[1]Island deconstruction activities in the winter and spring seasons are anticipated to use similar equipment that will be used during island construction; therefore, the Level B threshold is anticipated to be the same. With the exception of vibratory sheet pile removal, it is anticipated that there will be no other in-water work during the open-water season.

[2]To account for bowhead whale group size, the exposure estimate has been increased from 1 to 5.

Based on noise modeling for the Liberty Project (SLR Consulting 2017), Level A exposures from underwater noise are only possible during the open water season of year 1 and 2 for vibratory sheet pile driving, impact sheet pile driving, slope armor installation, and impact pipe driving (Table 17); however, considering the small Level A isopleths for vibratory sheet pile driving (0.02 km) and slope armor installation (less than 0.01 km), it is expected that shutdown procedures will reduce Level A take associated with these noise sources. Level A exposures for impact sheet pile driving and impact pipe driving were estimated by multiplying the Level A ensonified area (Table 17), by the seasonal density for each species (Table 18), by the number of days of impact sheet piling (15 days) and foundation piles/impact pipe driving (31 days) proposed in that season, and these numbers then rounded up to the nearest integer per stressor if the exposure estimate was less than one and then summed (Table 22). If the exposure estimate was greater than one, the exposure estimate was summed and then rounded to the nearest integer.

Table 22. Level A underwater noise exposure estimates for the proposed action.

Season	**Stressor**	**Hearing Group**	**Area of Level A Threshold (km^2)[1]**	**Year 1 and 2**			
				# of days of Stressor	**Bowhead**	**Ringed**	**Bearded**
Summer	Impact Sheet Pile Driving	Low Frequency Cetacean	5.91	15	0.35 *(rounded to 1)*	-	-
		Phocid Pinnipeds	0.87[2]		-	3.5	0.65 *(rounded to 1)*
	Foundation Piles/Impact Pipe Driving	Low Frequency Cetacean	2.38	31	0.37 *(rounded to 1)*	-	-
		Phocid Pinnipeds	0.18		-	1.50	0.28 *(rounded to 1)*
				Total Exposure	**2**	**5**	**2**

[1] Note that the ensonifed areas listed in Table 23 are halved from the area identified in Table 18 for sheet pile driving to account for the noise shadowing effect of the island (Hilcorp 2018a).
[2]The area is based on a maximum duration of 40 minutes, the average duration is 20 minutes per day (SMRU Consulting 2017).

Pile and pipe removal activities during Year 25 of decommissioning are anticipated to have the same estimated number of Level A exposures as driving activities in Year 1, resulting in the following total number of Level A takes (from pile and pipe installation and removal activities) for the duration of the project: (4) bowhead whales, (10) ringed seals, and (4) bearded seals.

In addition to Level A exposure estimates associated with underwater noise, there is the potential for Level A mortality or injury take from on ice activities (ice road construction, maintenance, and decommissioning). This stressor will be discussed further in Section 6.2.1.5.

6.1.1.5 Ice Road, Ice Trail, and Ice Pad Construction and Maintenance

As discussed in Section 2.1.1.1, the construction of ice roads, ice trails, and ice pads will require the use of graders, water pump units equipped with ice augers, and construction vehicles. During Northstar sound source verification studies, ice road construction produced the least amount of sound compared to island construction (including pile driving) and drilling. Based on a sound source verification study conducted at Northstar (Greene et al. 2008) and modeling conducted by SLR Consulting, it is anticipated that ice road, ice trail, and ice pad construction and maintenance activities will result in an average underwater sound pressure level of 189.1 dB re 1µPa (SLR Consulting 2017), and a Level B harassment threshold extending out to 0.17 km (558 ft; Table 17). Figure 30 shows the extent of the underwater behavioral threshold from ice road construction activities (which has the greatest propagation distance of on-ice activities). The in-air Level B harassment threshold is expected to be less than 0.02 km (66 ft; Table 17).

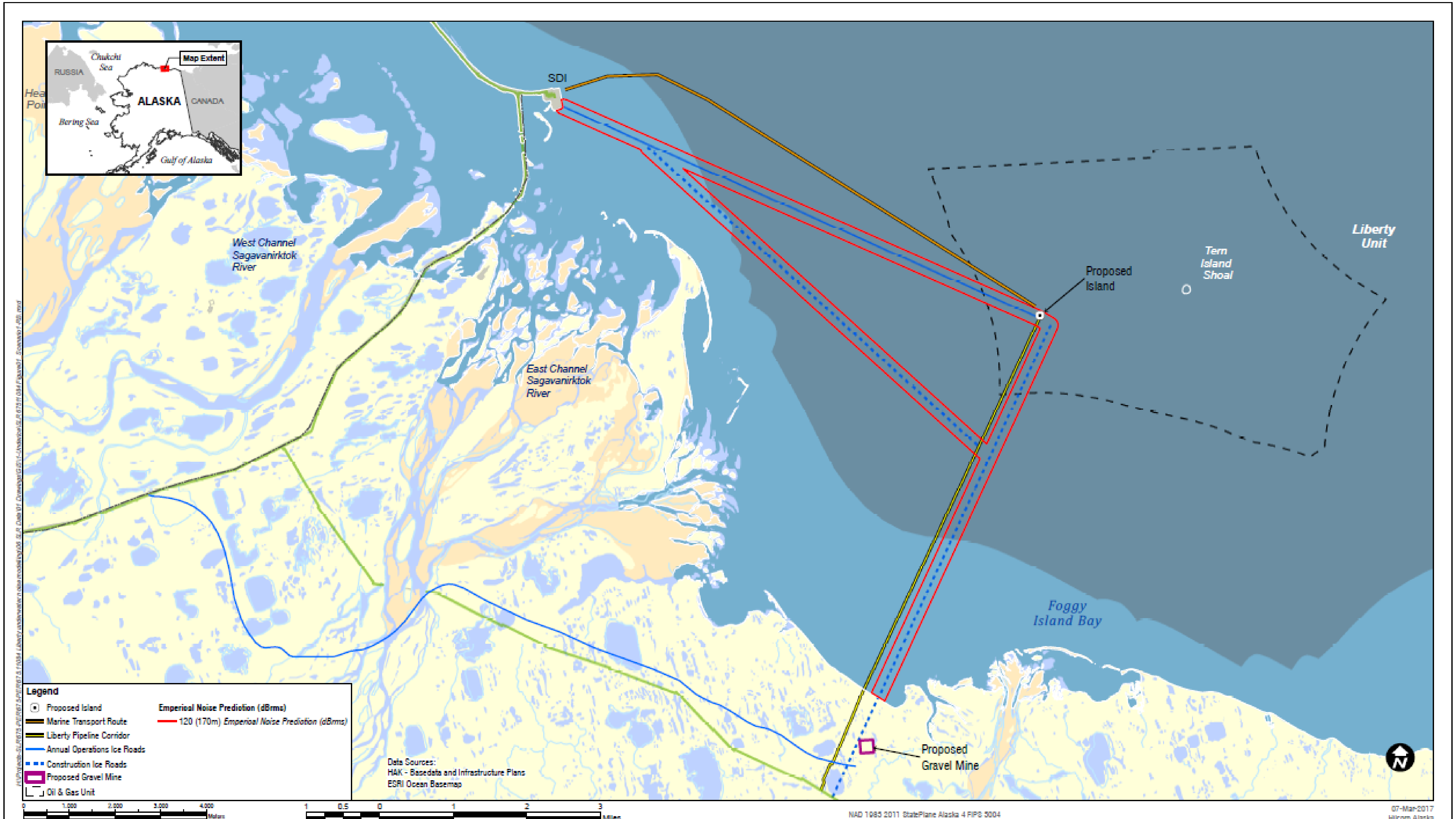


Figure 30. Ice road construction and maintenance behavioral threshold of 170 m (120 dB; SLR Consulting 2017).

Bowhead Whales

As discussed in Section 4.1.3, bowheads are not present within the action area during the ice covered season; therefore, on-ice activities (e.g., ice road, ice trail, and ice pad construction and maintenance) will have no effect on bowhead whales.

Ringed and Bearded Seals

Ringed and bearded seals could be encountered during the ice covered season; however, only a few bearded seals overwinter in the Beaufort Sea (see Section 4.1.5). Ringed seals are more likely to use shorefast ice areas surrounding the proposed LDPI during the ice-covered season (see Section 4.1.4). Although it is more likely that ringed seals would be encountered during the Liberty project, this section (Section 6.2.1.5) analyzes impacts on both ringed and bearded seals, and, unless specified, NMFS uses “seals” to denote both ringed and bearded seals. Seals may be encountered on floating ice within the action area, but are not expected to be present on bottom-fast ice, which typically occurs in waters with a depth of less than 3 m (9 ft).

Noise

Seals could be affected by noise (underwater and in-air) and vibrations associated with ice road, ice trail, and ice pad construction and maintenance and the physical presence of humans and project equipment. During ice road construction at Northstar the distance to the median background ambient sound for the strongest one-third octave bands for bulldozers, augers, and pumps was less than 2 km for underwater noise, 1 km for in-air noise, and 4 km for ice borne vibrations (Greene et al. 2008). Even though sound maybe audible or vibrations detectable out to these distances, it is not expected that seals will be affected at these distances. In addition to using NMFS generic sound exposure thresholds to determine whether an activity produces underwater sounds that might result in impacts to ringed and bearded seals, we also looked at the hearing sensitivity range to determine possible exposure.

Since there is a lack of information on underwater and in-air hearing sensitivities specific to ringed and bearded seals, we used available information on harbor seals (*Phoca vitulina*), a close relative of ringed and bearded seals. NMFS has defined phocid hearing range to be from 50 Hz to 86 kHz (which encompasses the hearing range all species within the group); however, the optimum underwater hearing sensitivity frequency range for harbor seals is 1 to 50 kHz with a rapid diminishing sensitivity at higher frequencies and a slow weakening sensitivity at lower frequencies (Richardson 2008). The majority of ice road construction noise occupies frequencies below the 1 kHz (or 1,000 Hz; Table 23). Ice trail and ice pad construction noises are anticipated to be similar to ice road construction. These frequencies are below the optimal hearing sensitivity range for harbor seals; therefore, ringed and bearded seals may not hear noise propagating to the distance of ambient background noise or the calculated Level B harassment threshold during ice road, ice trail, or ice pad construction and maintenance activities (Richardson 2008).

Table 23. Underwater sound source levels and frequencies measured during ice road construction at Northstar (Blackwell et al. 2004a, Greene et al. 2008, BOEM 2017a).

Sound Source	Broadband SPL at 100 m (dB re 1 µPa)	Frequency Bandwidth of produced noise ≥100 (dB re 1 µPa)
Ambient background noise[1]	78 – 110	20 Hz – 5 kHz
Bulldozer	114.2	31.5 Hz – 125 Hz
Augering	103.3	None
Pumping	108.1	500 Hz – 1 kHz
Ditchwitch	122	< 5 Hz – 3.15 kHz
Trucks	123.2	<5 Hz – 500 Hz
[1]Highly variable due to changing environmental variables.		

Seals hauled out on the sea ice could hear in-air noise from ice road, ice trail, or ice pad construction and maintenance up to 1 km away (0.6 mi) (Greene et al. 2008); however, based on NMFS 100 dB in-air Level B harassment threshold (see Section 6.1.1.1), harassment of seals hauled out on ice is only anticipated within 0.02 km (66 ft) from the noise source (Table 17). Aerial surveys conducted from 1997 through 2002 did not show any detectable effects from the Northstar development on the local distribution of basking ringed seals. Seals were often documented within 1 km of the island and ice roads. There were no significant differences between seal densities before development or closer to Northstar infrastructure and those farther away (Richardson 2008).

Additionally, unlike bearded seals, ringed seals build lairs typically concentrated along pressure ridges, cracks, leads, or other surface deformations (Smith and Stirling 1975, Hammill and Smith 1989, Furgal et al. 1996). Ringed seals create their lairs on relatively stable landfast ice (Williams et al. 2006), with at least 34 cm of ice (Hammill 1987). Industry needs similar stable ice for construction activities. Ringed seals located inside of lairs are expected to experience a considerable reduction in received in-air sound levels because snow dampens the effect of in-air noise on an order of ~40 dB (broadband) per meter of snow thickness (Blix and Lentfer 1992). The average snow depth of ringed seal lairs is 0.55 m but ranges from 0.20 to 1.2 m (Frost and Burns 1989, Richardson and Williams 2002, Richardson 2008). Since ringed seals spend approximately 180 days a year within snow covered subnivean lairs, ringed seals are unlikely to be impacted by in-air noise (Richardson 2008).

Seals on sea ice or in lairs may also sense vibrations from industry construction and operations. There are no specific studies assessing the sensitivity of seals to ice borne vibrations; however, Williams et al. (2006) shows that there was no documented change in the presence of ringed seals around the Northstar infrastructure from vibrations or in-air and underwater noise.

Williams et al. (2006) studied the use of ringed seal lairs near Northstar activities (including ice roads) and predicted that ringed seals lairs near the Northstar Island would likely have a higher abandonment rate. However, the abandonment rate was not significantly different closer to the Northstar infrastructure (less than 2 km), including ice roads, versus farther away (2 to 3.5 km). Ringed seals were detected building breathing holes and lairs within a few meters of ice roads before and during Northstar activities and maintained these structures for extended periods of time (up to 163 days). Ringed seals were documented creating and using sea ice structures within 11 to 3,500 m (36 to 11,482 ft) of Northstar activities. Birth lairs closest to North Star infrastructure were 882 m and 144 m (2,894 and 374 ft) from the island and ice road, respectively (Williams et al. 2006). Spring ice road traffic did not influence ringed seal use of sea ice. Two basking holes were found within 11 and 15 m (36 and 49 ft) from the nominal centerline of a Northstar ice road and were still in use by the end of the study (Williams et al. 2006). The analysis suggested (with marginal significance) that abandonment was more likely to occur farther from ice roads. Williams et al. (2006) found that abandonment of ice structures was strongly related to: 1) the time of year when the structure was originally found, and 2) ice deformation, rather than the distance from Northstar activities. Higher densities occurred in areas with lower ice deformation (Moulton et al. 2002b, Moulton et al. 2005). Adult ringed seals must balance the need to use habitats with some ice deformation (which promotes the snow accumulation needed for lairs) against the possible instability of deformed ice and its possible use as cover by approaching polar bears (Williams et al. 2006).

Direct Harassment, Injury, and Mortality

In addition to acoustic harassment, seals may be physically harassed, injured, or killed by the use of on-ice equipment associated with ice roads, ice trails, and ice pads. Since 1998, there have been three documented incidents of ringed seal takes from oil and gas activities on the North Slope, with one recorded mortality. On April 17, 1998, during a vibroseis on-ice seismic operation outside of the barrier islands east of Bullen Point in the eastern Beaufort Sea, a ringed seal pup was killed when its lair was destroyed by a Caterpillar tractor clearing a road. The lair was located on ice over water 9 m (29 ft) deep with an ice thickness of 1.3 m (4.3 ft). It was reported that an adult may have been present in the lair when it was destroyed. Crew found blood on the ice near an open hole approximately 1.3 km (0.8 mi) from the destroyed lair; this could have been from a wounded adult (MacLean 1998). On April 24, 2018, a tucker traveling on a Northstar sea ice trail broke through a brine pocket. After moving the tucker, a seal pup climbed out of the hole in the ice, but no adult was seen in the area. The seal pup remained in the area for the next day and a half. This seal was seen in an area with an estimated water depth of 6 to 7 m (20 to 24 ft) (Hilcorp 2018b). The third reported incident occurred April 28, 2018, when an ENI contractor performing routine maintenance activities to relocate metal plates beneath the surface of the ice road from Oliktok Point to Spy Island Drillsite spotted a ringed seal pup next to what may have been a disturbed lair site. No adult was seen in the area. The pup appeared to be acting normally and was seen going in/out of the opening several times (ENI 2018).

Hilcorp plans to commence winter activities on the sea ice as early as practical, and prior to March 1 of each year before female ringed seals have established their birth lairs. On-ice construction activities initiated (in an undisturbed area) after March 1 may harm or harass ringed seals in lairs which are virtually undetectable. To minimize the risk of takes of ringed seals from on-ice activities, Hilcorp will adhere to Ice Road and Ice Trail Best Management Practices developed in collaboration with and approved by NMFS (see Section 2.1.2.2).

Given that there was no significant difference in the presence of seals before and after the development of the Northstar Island and given the implementation of the above mitigation measures for the Liberty project, it is expected that only a small number of adult ringed seals and pups could be affected or displaced by ice road, ice trail, and ice pad construction and maintenance in association with the proposed action. Hilcorp has requested takes for two ringed seal mortalities every 5 years in association with on-ice activities. In addition, we estimated up to two ringed seals may be disturbed per year by physical presence of equipment and people. The effects may occur periodically over the 25-year life of the proposed action, but only when ice roads, ice trails, and ice pads are constructed and used.

6.1.1.6 Island and Pipeline Construction

As discussed in Sections 2.1.1.2 and 2.1.1.3, island and pipeline construction activities will include the cutting and removal of sea ice, the placement of gravel (at the LDPI location), the installation of a subsurface marine pipeline, the installation of slope protection materials (sheet piles and slope armament), the installation of conductor pipes, and the construction of surface facilities. Depending on the island and pipeline construction activity, project activities are expected to produce noise that reaches Level B harassment thresholds from 0.01 km (33 ft; for conductor pipe impact driving) to 0.39 km (1,280 ft; for vibratory sheet pile driving) during the ice-covered season and 0.31 km (0.2 mi; for conductor pipe impact driving) and 14.8 km (9 mi; for vibratory sheet pile driving) during the open water season (see Table 17). Figure 31 through Figure 36 show the extent of underwater behavioral thresholds for each island and pipeline construction activity.

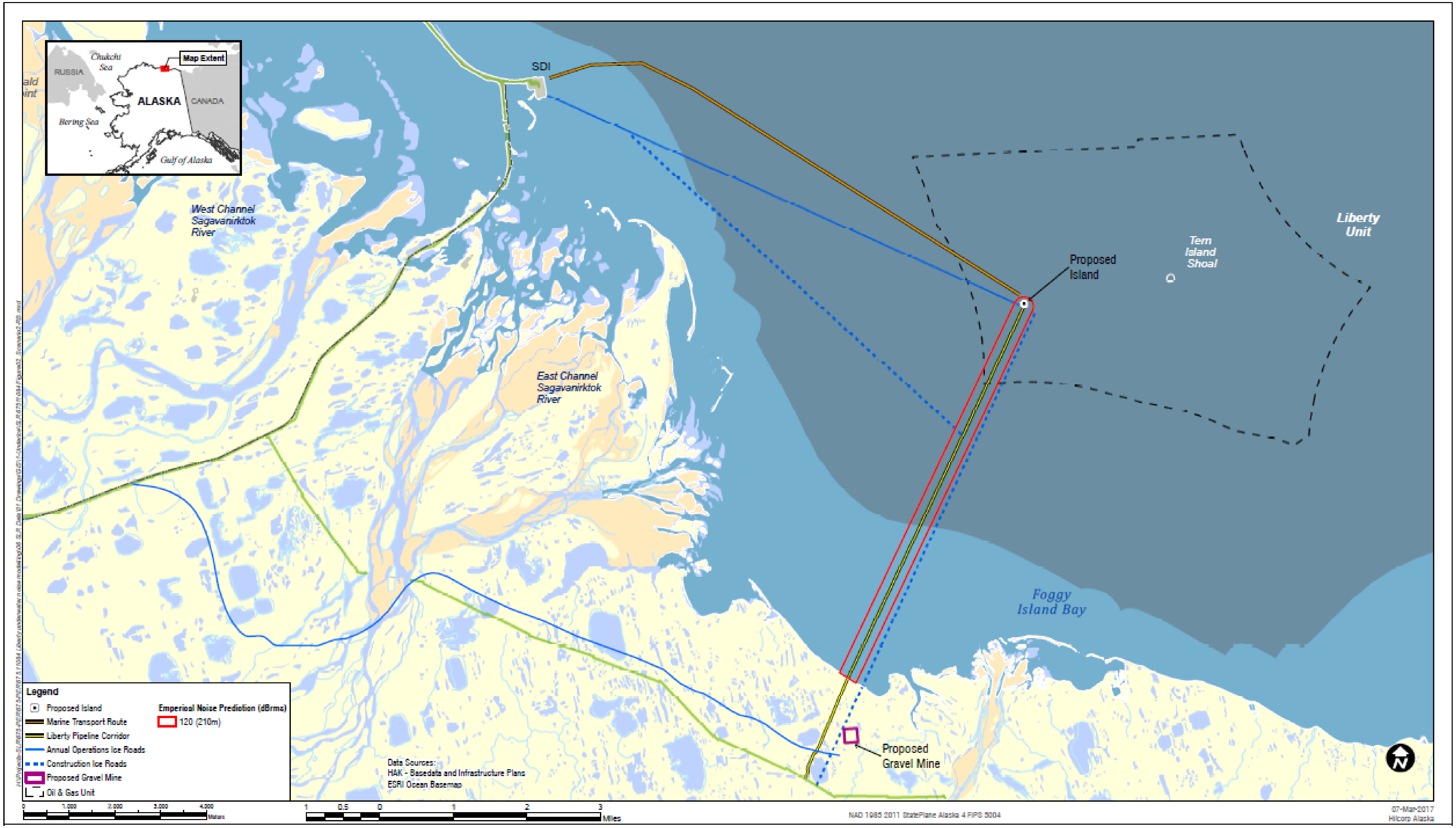


Figure 31. Pipeline construction behavioral threshold (120 dB) of 210 m during ice-covered conditions (SLR Consulting 2017).

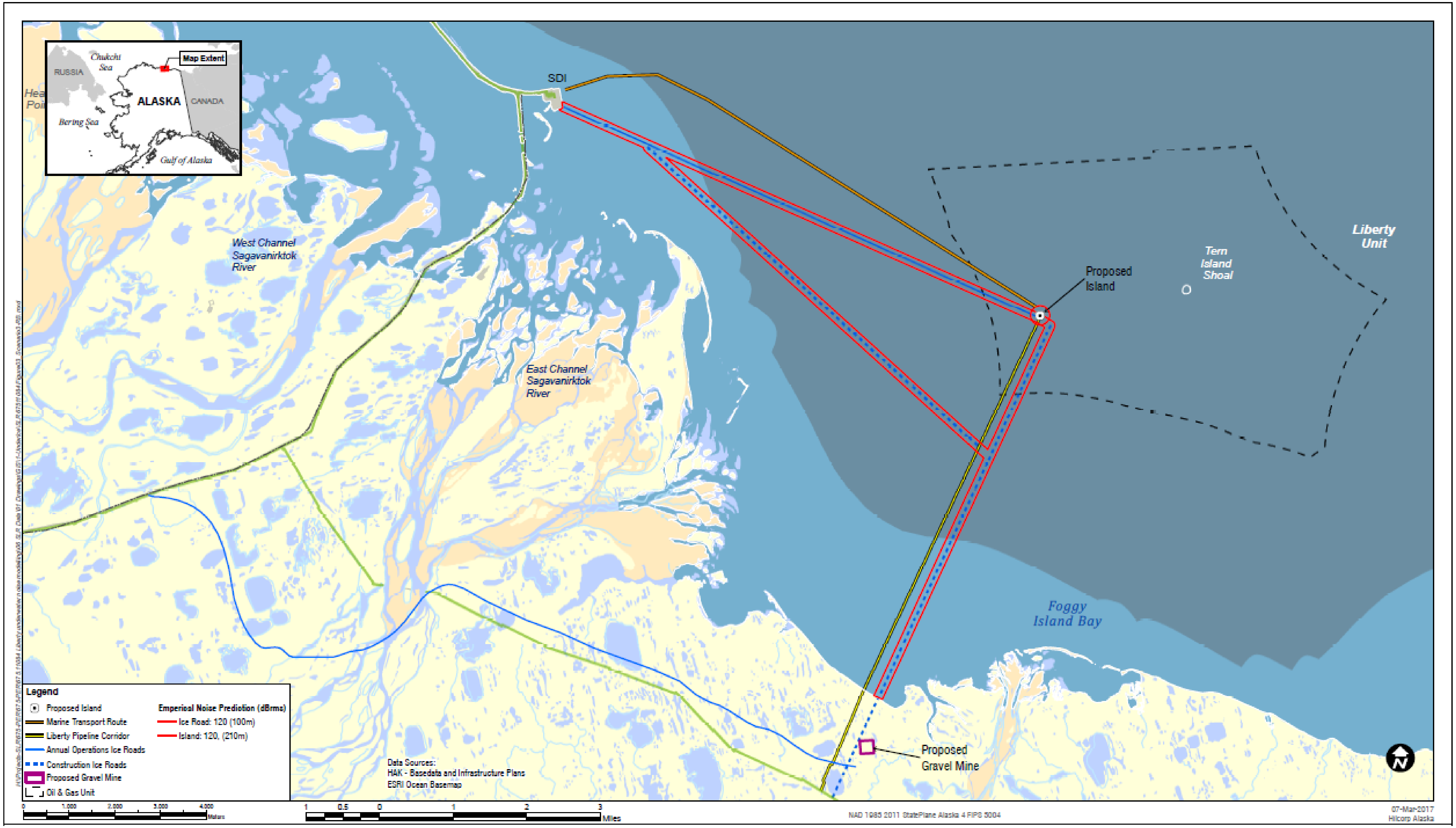


Figure 32. Island construction behavioral threshold (120 dB) of 210 m during the ice-covered conditions (not including effects due to pile driving sound associated with construction) (SLR Consulting 2017).

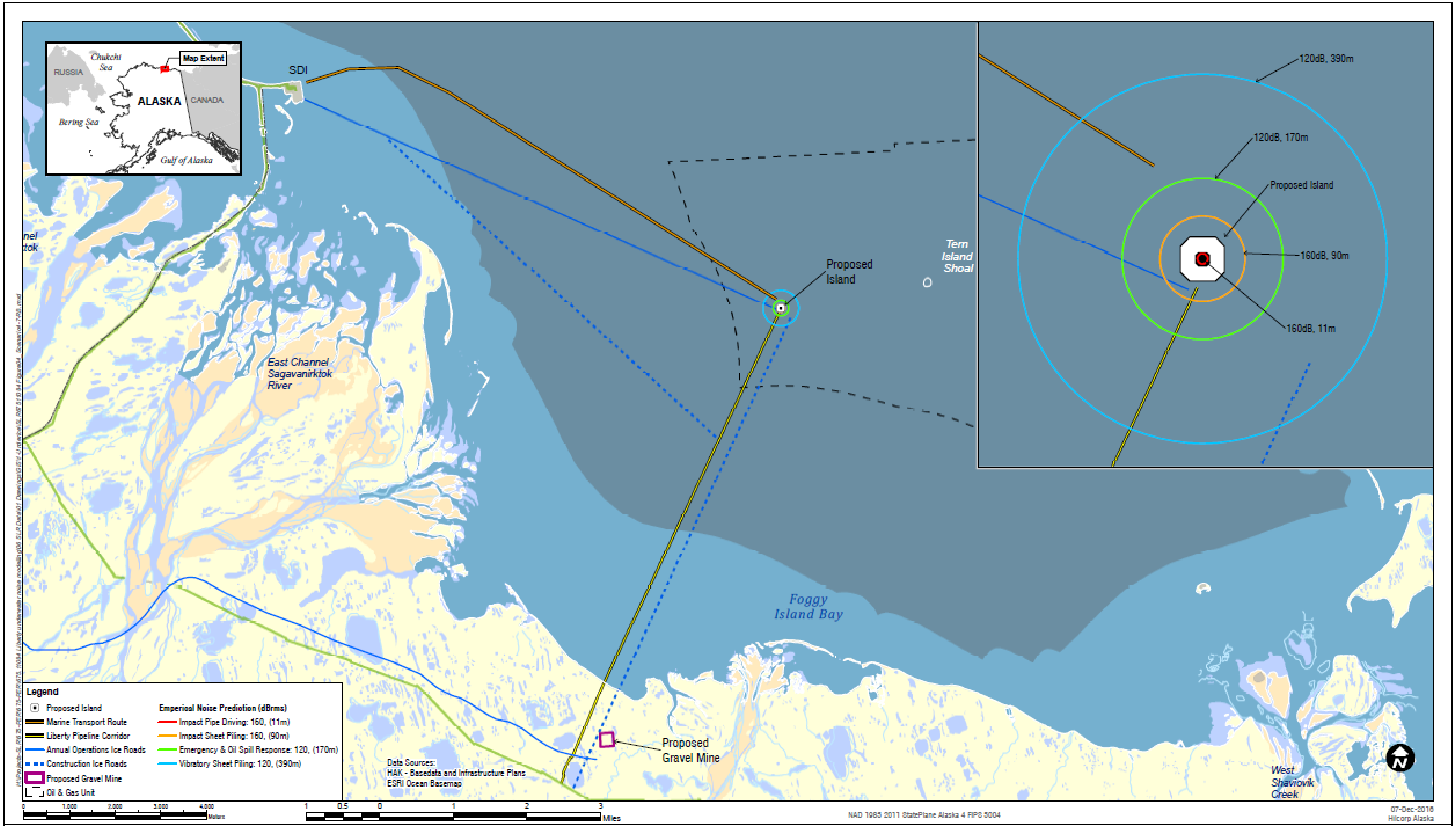


Figure 33. Sheet pile driving (impact and vibratory) and pipe driving (impact) behavioral thresholds during ice-covered conditions (SLR Consulting 2017).

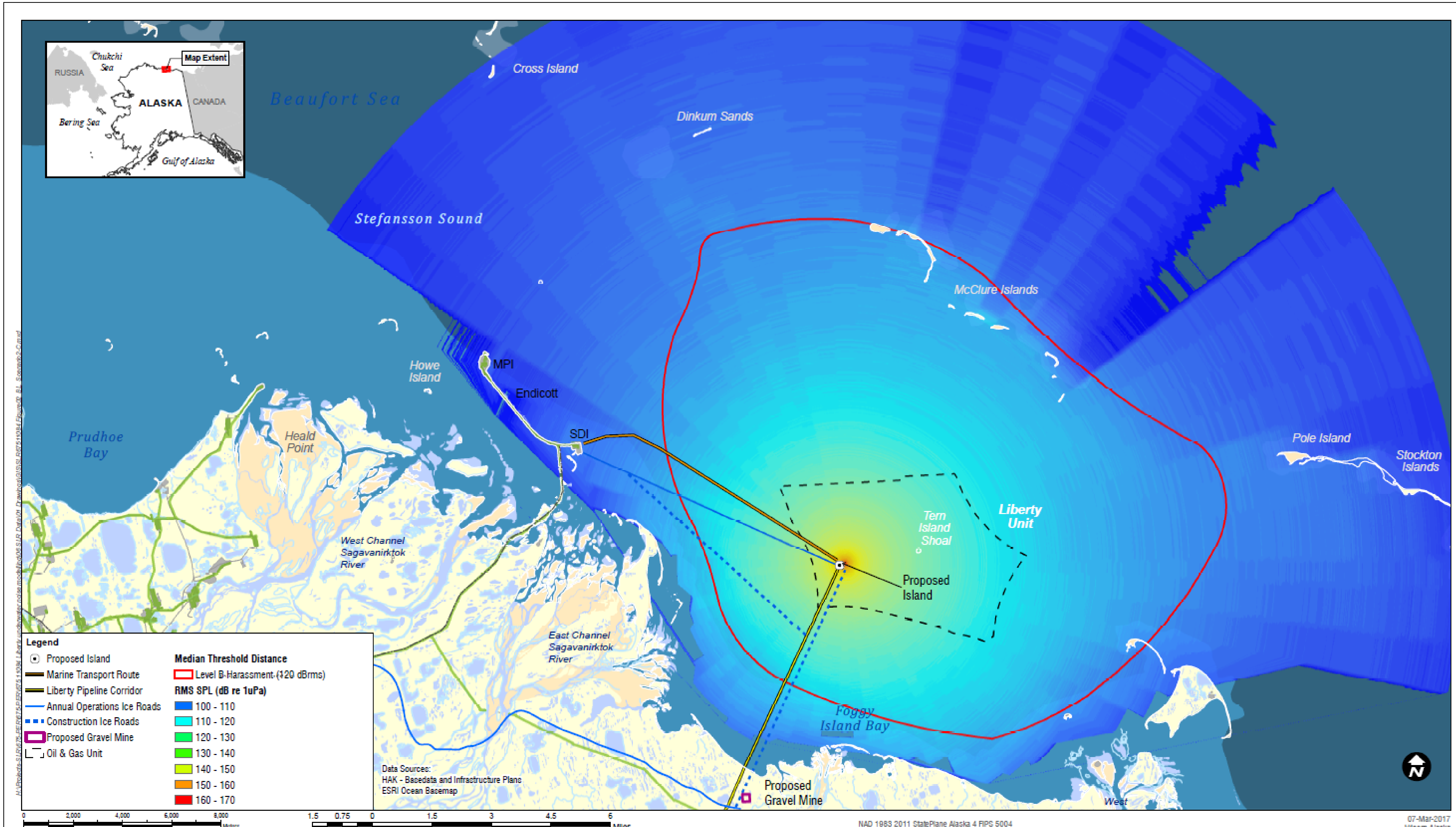


Figure 34. Vibratory sheet pile driving behavioral threshold during the open-water season (SLR Consulting 2017).

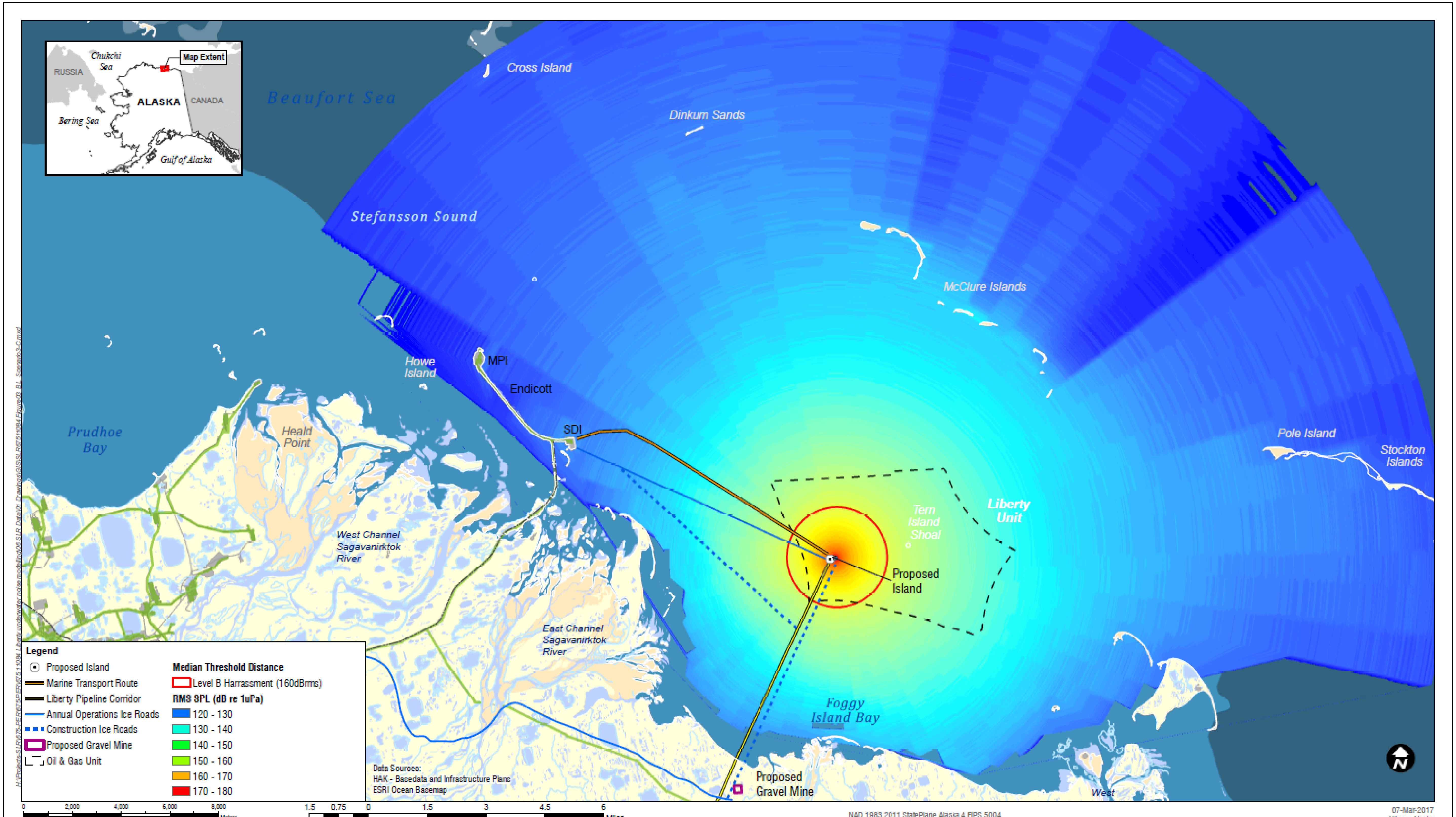


Figure 35. Impact sheet pile driving behavioral threshold during the open-water season (SLR Consulting 2017).

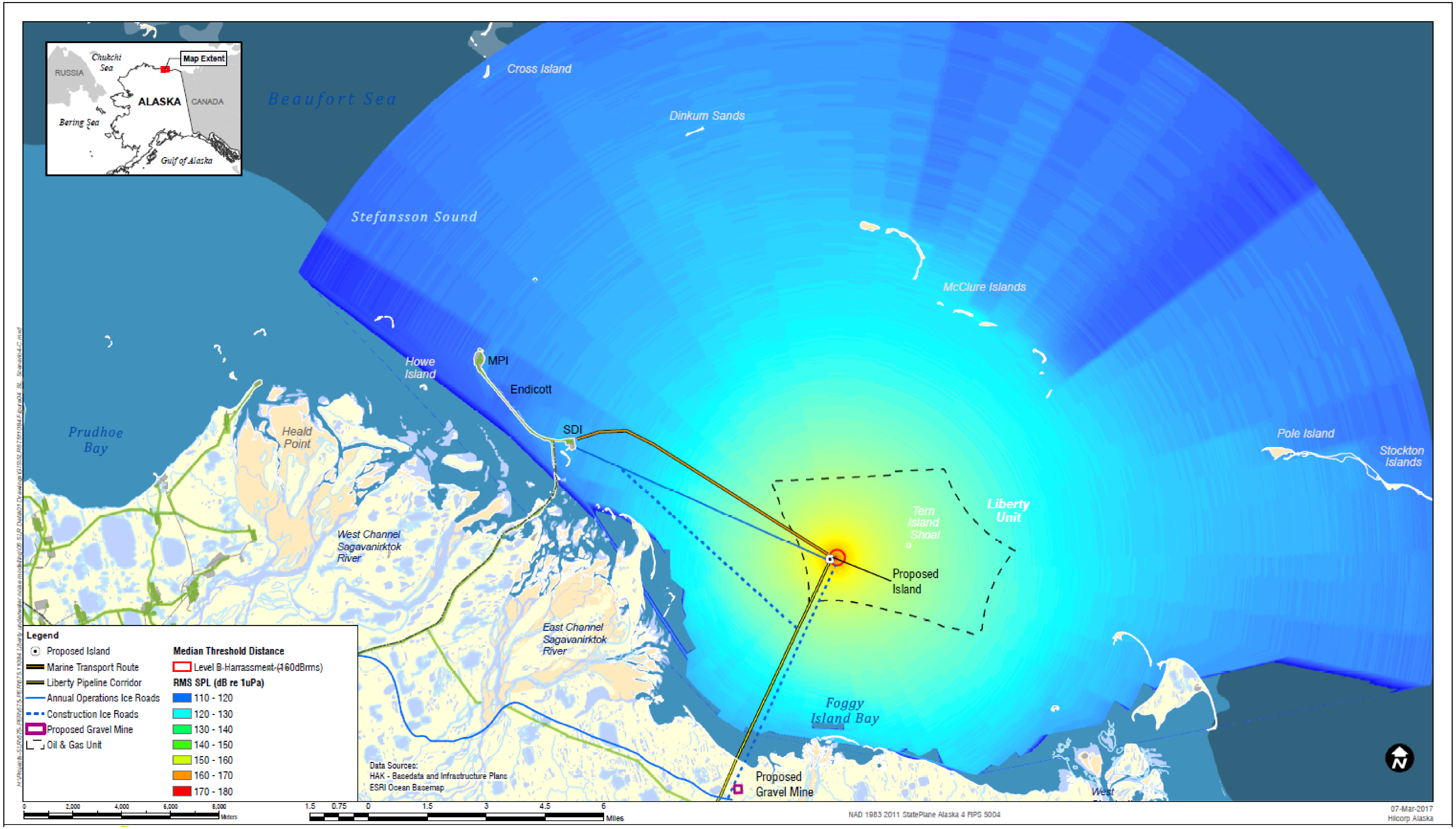


Figure 36. Impact pipe driving behavioral threshold during the open-water season (SLR Consulting 2017).

Bowhead Whales

Most of the proposed activities associated with the installation of the gravel island and the subsurface pipeline would have no effect on bowhead whales because these activities would occur during winter when bowheads are absent from the action area. In the spring, the installation of slope protection materials (sheet piles and slope armament) would overlap in time temporarily with the bowhead whale spring migrations into the Canadian Beaufort Sea (in mid-May through mid-June); however, the spring migration occurs over the continental shelf break, well offshore of the action area (see Section 4.1.3). Bowheads maybe exposed to noise from installation of slope protection (sheet piles and slope armament) and pipe driving activities during the summer months.

Sheet Pile Driving, Slope Armor Installation, and Pipe-driving

Bowhead whales generally do not migrate inside of the barrier islands; however, individuals have been occasionally observed shoreward of the islands. Most sound from proposed LDPI and pipeline construction activities are unlikely to affect bowhead whales as noise produced above the 120 dB behavioral threshold for continuous noise and the 160 dB behavioral threshold for impulsive noise only extend beyond the barrier islands slightly during the open-water season for vibratory sheet pile driving (see Figure 31 through Figure 36). The barrier islands are predicted to provide a “shielding” effect for the propagation of underwater noise (Richardson et al. 1995, MMS 2002, SLR Consulting 2017). Bowhead whales near the open water between barrier islands and whales that enter Foggy Island Bay may be affected by noise from sheet pile driving, slope armor installation, and pipe driving.

Bowhead whales may have a behavioral response or experience TTS from these project activities, but are not expected to experience PTS. All four activities (impact and vibratory sheet pile driving, slope armor installation, and impact pipe driving) have the potential to expose bowhead whales (categorized in the low frequency cetacean hearing group) to PTS (SLR Consulting 2017); however, during the open water season, vibratory sheet pile driving and slope armor installation have small PTS threshold distances of 0.02 km (66 ft) and less than 0.01 km (33 feet), respectively, and bowhead whales are not expected to be that close to the LDPI during this time. In addition, standard shutdown mitigation will be applied if bowhead were to enter the Level A zones. No level A take is anticipated for sheet pile driving, slope armor installation, and pipe-driving.

Impact sheet pile driving and pipe driving have estimated PTS thresholds of 1.94 km (6,365 ft) and 0.87 km (2,854 ft), respectively. Hilcorp has committed to shutting down when a bowhead whale is likely to enter the Level A harassment zone; therefore minimizing the risks of PTS (see Section 2.1.2). However, these Level A zones are relatively large, and bowhead whales may be missed prior to entering a Level A zone. Hilcorp is requesting two Level A takes for impact pile and pipe driving during construction (with the potential for four Level A takes over the life of the project). This is likely an overestimate on potential Level A exposure since it exceeds the number of bowhead whales recorded inside Foggy Island Bay in any given year (MMS 2002). While bowhead whales have been seen at a distance of 11 km (7 mi) from the LDPI island, they have not been recorded (during aerial surveys or from subsistence whalers’ observations) inside the Level A threshold zone for any of the four activities that could cause PTS (MMS 2002).

Bowhead whales may be disturbed or displacement from impact and vibratory sheet pile driving, slope armor installation, and impact pipe driving. During the construction of artificial islands and other oil-industry facilities in the Canadian Beaufort Sea in late summers of 1980 through 1984, bowhead whales were at times observed as close as 0.5 mi (0.8 km) from the construction sites (Richardson et al. 1990, Richardson et al. 1995c). During these periods, bowheads generally tolerated playbacks of low-frequency construction and dredging noise at received broadband levels up to about 115 dB re 1 μPa during (Richardson et al. 1990). At received levels higher than about 115 dB, some avoidance reactions were observed. Bowheads reacted in only a limited and localized way (if at all) to construction of Seal Island, the precursor of Northstar (Hickie and Herrero 1983). Pile driving activities at Northstar occurred during the ice-covered season and therefore did not affect bowhead whales.

Given that bowhead whales are rarely observed within Foggy Island Bay and given the implementation of mitigation measures to shut down sheet pile driving, slope armor installation, and pipe driving prior to a bowhead whale entering the Level A threshold, it is unlikely that bowhead whales will be close enough to the LDPI to experience PTS. Noise from pile-driving could behaviorally disturb bowhead whales, but again because of the lack of bowheads observed in Foggy Island Bay, the sound propagation characteristics of sheet and pile driving in the Beaufort Sea, and the implementation of mitigation measures (see Section 2.1.2.2), the probability of harassment due to sheet pile driving, slope armor installation, and pipe driving is limited, but may adversely affect those animals potentially exposed.

Facilities Construction

Facility construction includes the installation of all LDPI surface facilities, structures, and equipment on the LDPI in preparation for drilling, development, and production of the Liberty petroleum reserves. There is no in-water work associated with facility construction on the LDPI (see Section 2.1.1.4). However, facilities construction could impact bowheads with the presence of aircraft and marine traffic during the open-water season as these vessels carry equipment and materials used to construct surface facilities. The potential effects of vessels and aircraft associated with the proposed action are analyzed in Sections 6.2.1.8 and 6.2.1.9, respectively

Ringed and Bearded Seals

Ringed and bearded seals could be encountered during island and pipeline construction activities occurring during the ice-covered or open-water season. However, bearded seals that overwinter in the Beaufort Sea tend to be near lead systems and polynyas seaward of the barrier islands (see Section 4.1.5); therefore, the likelihood of bearded seals being in the action area during the ice-covered season is low. Ringed seals are more likely to use shorefast ice areas surrounding the proposed LDPI during the ice-covered season (see Section 4.1.4). If bearded seals are exposed to construction activities during the ice-covered season, responses would likely be similar to those of ringed seals.

Gravel Placement and Pipeline Installation

Effects to ringed and bearded seals from the installation of gravel at the LDPI and subsurface pipeline will be during the ice-covered season. Seals could occur on floating ice (water depths greater than 3 m) near the location of the LDPI and along the proposed pipeline route.

Approximately half of the 7 mi subsurface pipeline construction is likely to occur in winter and spring ringed seal habitat. The remaining half of the pipeline would be laid through ice frozen into the seabed.

To install the gravel island and subsurface pipeline, Hilcorp will use a Ditch Witch to cut through the ice where the gravel will be placed and the pipeline trench will be dug for installation of the subsurface pipeline. Noise generated from the use of the Ditch Which and the excavator will produce an underwater 120 dB Level B harassment threshold distance of 0.21 km (689 ft; Table 17 and Figure 31) and is not expected to produce noise that exceeds the Level A injury threshold criteria or PTS (see Section 0). Effects from underwater noise, in-air noise, and vibrations are expected to be the same as described for ice road, ice trail, and ice pad construction and maintenance activities (see Section 6.2.1.5). In addition, the open water left by the trenching activities might attract seals to bask, forage, or create new dens or breathing holes. Considering similar techniques were used in the construction of the Northstar island and there was no documentation of displacement or disturbance from these construction activities (Richardson 2008), it is expected that seals will be respond to these same construction activities at the Liberty Project location in a similar way.

Sheet Pile Driving, Slope Armor Installation, and Pipe-driving

Sheet pile driving, slope armor installation, and pipe-driving are the three loudest noises associated with the proposed action. Effects on ringed and bearded seals are expected to be similar to those observed at the Northstar Island. Behavioral observations at Northstar provided information on seal distribution, abundance, and behavior during periods with and without impact pipe-driving and other construction activities. Ringed seals were observed in water and on melting sea ice near the island during the installation of sheet pile, slope armor, and conductor pipes during June and July (Blackwell et al. 2004a, Richardson 2008). Ringed seals indicated some degree of tolerance to Northstar sounds as they were frequently observed from vessels and the island, which was likely due to the following factors: apparent low sensitivity to disturbance, habituation, reduced audiometric sensitivity at low frequencies, and potential curious behavior of immature animals (Richardson 2008).

Nearly 55 hours of behavioral observations were documented around the Northstar Island, with 40.25 hrs during pipe-driving activities. Of the 23 ringed seals documented, 17 were basking on the ice within 0.5 to 2 km from the eastern edge of the island and 6 were swimming in the moat within 3 to 15 m of the island edge. During pipe-driving activities 15 of these seals were basking on the ice and 5 in the moat. None of the seals reacted to pipe-driving activities, but some reacted to low-flying helicopters (see Section 6.2.1.10). Seals with no observed negative reactions to pipe-driving activities included a juvenile swimming within 3 m of the water’s edge (Blackwell et al. 2004a). Blackwell et al. (2004a) noted that the seal seemed unaffected by the acoustic and visual stimuli associated with pipe-driving and approached the water’s edge to investigate crews.

Given that seals in the water and on ice did not react to similar construction activities at the Northstar Island and given the implementation of mitigation measures (see Section 2.1.2), we conclude that impacts to ringed and bearded seals from the installation of sheet pile, slope armor, and pipe driving will be minor (see Table 22) and adverse effects will be limited to behavioral reactions.

Facilities Construction

Facility construction includes the installation of all LDPI surface facilities, structures, and equipment on the LDPI in preparation for drilling, development, and production of the Liberty petroleum reserves. There is no in-water work associated with facility construction on the LDPI (see Section 2.1.1.4). Facilities construction could impact ringed and bearded seals with the presence of aircraft and marine traffic during the open-water season as these vessels carry equipment and materials used to construction surface facilities. The potential effects of vessels and aircraft associated with the proposed action are captured in Sections 6.2.1.8 and 6.2.1.9, respectively.

6.1.1.7 Drilling and Production Operations

As discussed in Sections 2.1.1.5 and 2.1.1.6, drilling and production will occur throughout all four seasons. Drilling operations will occur mostly within the first 5 years, after the drill rig is in place, and intermittently for the remainder of the project (years 6 through 23). Production will begin once a producing well is drilled and will continue for the life of the project. When drilling and production occur concurrently, the underwater Level B harassment threshold during the ice-covered season is expected to be 0.23 km (755 ft) and approximately 0.06 km (197 ft) during the open-water season Table 17. During times when drilling will not be occurring, noise exceeding the underwater Level B harassment threshold from productions and operations is expected to extend for 0.04 km (131 ft) in the ice-covered season and for 0.05 km (164 ft) in the open-water season. In-air noise is expected to extend to the Level B harassment threshold at 0.03 km (98 ft). Figure 37 through Figure 38 show the extent of underwater behavioral thresholds for drilling and production activities. Hilcorp plans to complete a sound source verification study to determine the sound source levels and propagation of drilling and production noise around the LDPI. Given the information currently available, we conclude that drilling and production operations is likely to adversely affect ringed and bearded seals (see Table 22).

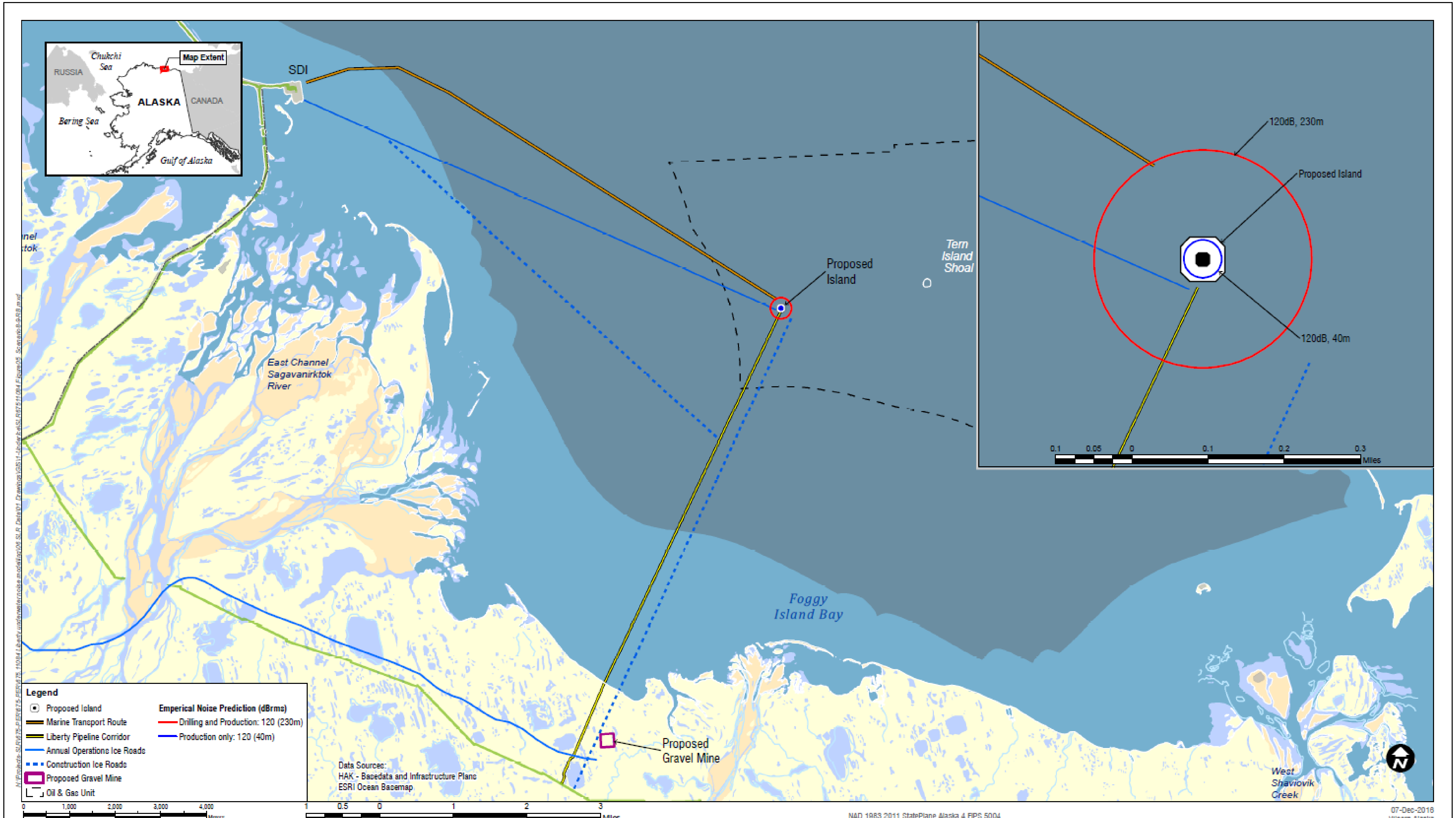


Figure 37. Drilling and production behavioral thresholds during ice-covered conditions (SLR Consulting 2017).

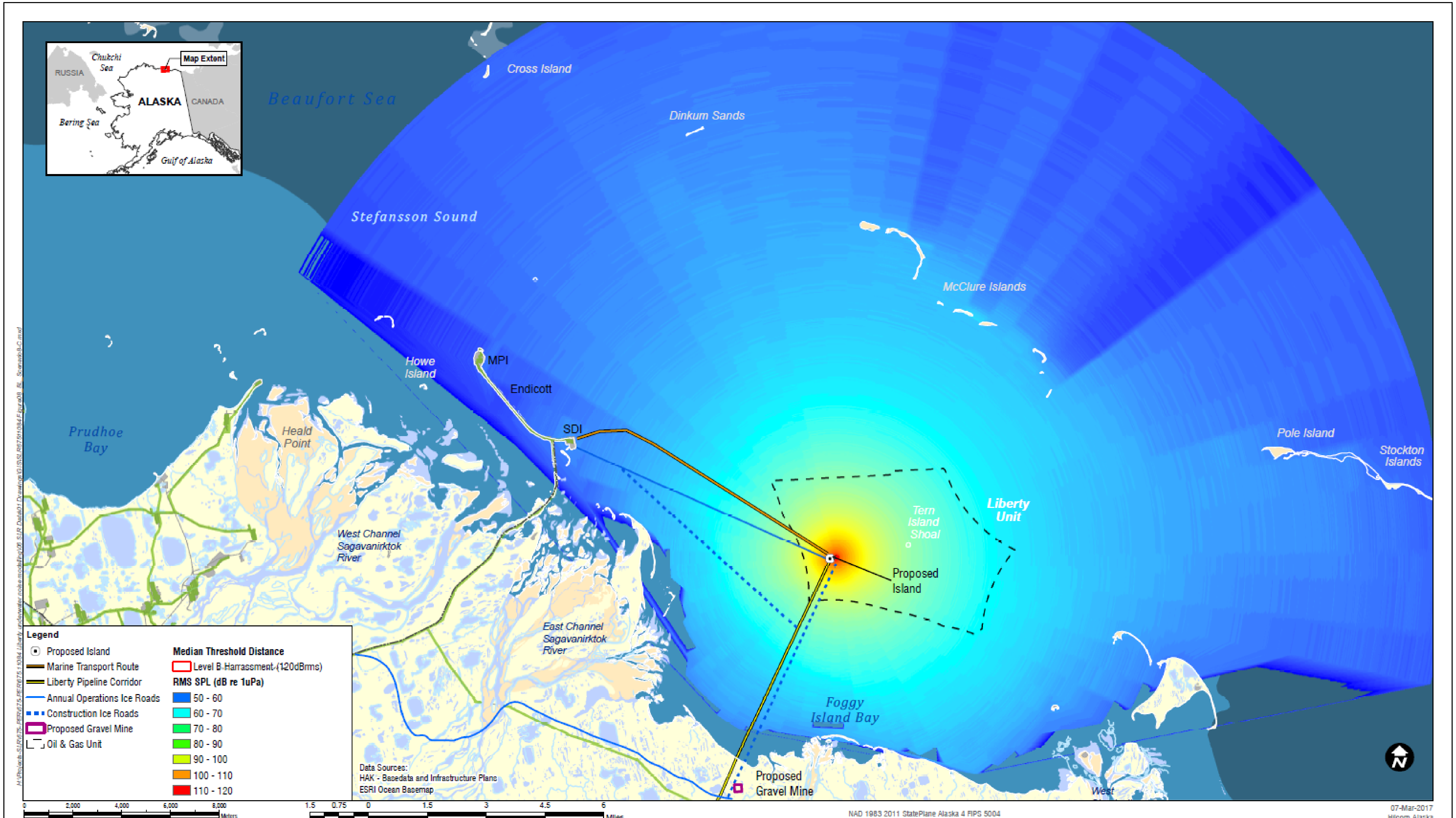


Figure 38. Drilling and production behavioral thresholds during open-water conditions (SLR Consulting 2017).

Bowhead Whales

Drilling and production activities have the potential to disturb and displace bowhead whales from anthropogenic noise. As discussed in Section 4.1.3, bowhead whales are rarely documented inside of the barrier islands. Noise associated with drilling and production is projected to extend to ambient noise conditions slightly outside of the barrier islands during the open-water season (Figure 38); however, the underwater Level B threshold for harassment is 50 to 60 m (164 to 197 ft) from the LDPI, well within Foggy Island Bay. Given this, only a small number of bowhead whales may be affected from noise associated with drilling and production.

Bowhead whale reactions to drilling operation noise is variable. Richardson and Malme (1993) suggest that stationary industrial activities producing continuous noise, such as drilling from an island, result in less dramatic reactions by whales than do moving sources, particularly ships. It also appears that bowhead avoidance is less around an unattended structure than one attended by support vessels. Playback, modeling, and simulation studies have shown bowhead whales begin showing behavioral responses to low-frequency industrial sounds when received levels exceed 115 to 120 dB re 1 μPa (Richardson et al. 1990, Richardson et al. 1995c, Ellison et al. 2016).

Bowhead whales have been observed well within the ensonified zones around active drill ships, while playbacks of drillship noise to a small number of bowheads demonstrated some avoidance. Playbacks of the *Explorer II drillship* noise (excluding components below 50 Hz) showed that some bowheads reacted to broadband received levels near 94 to 118 dB re 1 μPa – no higher than the levels tolerated by bowheads seen a few kilometers from drillships (Richardson et al. 1990, Richardson et al. 1995c). The playback results of Wartzok et al. (1989) seem consistent: the one observed case of strong avoidance of Kulluk drilling noise was at a broadband received level greater than or equal to 120 dB.

During the 2012 drilling season, bowhead whales lingered within the Chukchi Sea lease sale area, co-occurring with drilling operations by Shell at the Burger Prospect (Quakenbush et al. 2013). During fall migration, 98 percent of tagged bowhead whales entered the lease area 193 (Quakenbush et al. 2013). There were a total of 107 cetaceans observed by PSOs aboard vessels in the Chukchi Sea during the 2012 drilling season, while the *Discoverer* was conducting drilling operations. However, all but two of these individuals were recorded from distant support vessels in areas where received levels from drilling activities was less than 120 dB_{rms} (Bisson et al. 2013). The remaining two unidentified mysticetes were anticipated to have been exposed to sounds between 130-140 dB from MLC construction operations at approximately 1.6 to 2 km from the vessel (Bisson et al. 2013).

Bowhead whales may react differently around drillships and exploratory operations (indicated above) than stationary island drilling operations (similar to Northstar and the proposed LDPI). The overall received level of drilling sound from Northstar Island generally diminished to 115 dB within 1 km (0.62 mi; (Blackwell et al. 2004b). McDonald et al. (2006a) reported subtle offshore displacement of the southern edge of the bowhead whale migratory corridor offshore from the drilling on Northstar Island. However, subsequent analyses revealed the modification in their migration route was due to environmental conditions, not noise from Northstar, although they reduced their vocalizations until passing west of the island, and a fraction of whales slightly shifted their travel routes to the north in years when noise levels from Northstar were above ambient (Blackwell and Greene 2006, Aerts and Richardson 2009, Richardson et al. 2012). Because of the proposed LDPI location, water depth, and distance of proposed LDPI from the bowhead whale fall migration route, the effects of noise associated with drilling operations are anticipated to be minimal and not result in significant behavioral disruption for those few animals that may be exposed.

Ringed and Bearded Seals

The effects of offshore drilling on ringed and bearded seals in the Beaufort Sea have been investigated in the past (Frost et al. 1988, Moulton et al. 2003). Frost et al. (1988) concluded that local seal populations were less dense within a 3.7 km (2 nautical miles) buffer from offshore wells that were being constructed from 1985 through 1987. Richardson et al. (1990) reported that ringed and bearded seals appeared to tolerate playbacks of underwater drilling sounds and dove within 50 m of these projected broadcasts. At that distance, the received sound level at depths greater than a few meters was approximately 130 dB re 1 μPa.

Richardson and Williams (2004) concluded that the low-frequency industrial sounds emanating from the Northstar facility during the open-water season resulted in brief, minor localized effects on ringed seals. However, Moulton et al. (2003) reported no indication that drilling activities at BP's Northstar oil development affected ringed seal numbers and distribution, although drilling and production sounds from Northstar could have been audible to ringed seals, out to about 1.5 km in water and 5 km in air (Blackwell et al. 2004b). However, the 5 km estimate assumes that ringed seals are on the surface of the snow or ice, but in reality they spend ~180 days insulated by snow cover when present in their subnivean lairs. Snow has a notable dampening effect on in-air sounds, on the order of ~40 dB (broadband) per meter of snow thickness (Blix and Lentfer 1992). In the Northstar region of the nearshore Beaufort Sea, a typical ringed seal lair likely would not be covered by a meter of snow. Snow depth over the lairs located ranged from 0.20 to 1.2 m (mean 0.55; Richardson 2008), and Frost and Burns (1989) reported a mean drift depth of approximately 0.6 m where they found lairs. Therefore, ringed seals resting in a lair would still experience a considerable reduction in received levels of airborne sounds, and in the range of detectability of those sounds. If, for example, the reduction were 20 dB, as expected below approximately 0.6 m of snow, airborne sounds from drilling and production would likely not be detectable in an enclosed lair at distances greater than ~1 km from the island.

Adult ringed seals seem to habituate to long-term effects of drilling activities. Moulton et al. (2003) found seal densities on the same locations to be higher in years 2000 and 2001 after initial exposure and a habituation period. Thus ringed seals were briefly disturbed by drilling activities, until the drilling and post-construction activity was concluded; then they adjusted to the environmental changes for the remainder of the activity. Additionally, Brewer and Hall (1993) noted ringed seals were the most common marine mammal sighted and did not seem to be disturbed by drilling operations at the Kuvlum #1 project in the Beaufort Sea.

McDonald et al. (2007) evaluated the potential impacts of offshore exploratory drilling on ringed seals in the near shore Canadian Beaufort Sea, during February to June 2003-2006. The first 3 years of the study (2003-2005) were conducted prior to industry activity in the area, while a fourth year of study (2006) was conducted during the latter part of a single exploratory drilling season. Seal presence in the nearshore Canadian Beaufort was not significantly different in distance from industrial activities during the non-industry (2003 and 2004) and industry (2006) years. Further, the movements, behavior, and home range size of 10 seals tagged in 2006 also did not vary statistically between the 19 days when industry was active (20 March to 8 April) and the following 19 days after industry operations had been completed. The density of basking seals was not significantly different among the different study years and was comparable to densities found in this same area during surveys conducted from 1974 through 1979. In addition, no detectable effect on ringed seals was observed during the single season of drilling in the study area (Harwood et al. 2007).

During Shell's 2012 drilling operations in the Chukchi Sea, a total of 396 seals were observed by PSOs. It was impossible to determine precisely how many seals represented sightings of new individuals or if they were re-sightings of seals that already had been observed and recorded in the area. The vast majority (93 percent) of the seal sightings were recorded when the pilot hole was being drilled. The remaining 26 seals were observed during mudline cellar construction. The estimated radius to underwater received levels greater than or equal to 120 dB_{rms} during pilot hole drilling was 1.5 km (Bisson et al. 2013). Of the 396 seals recorded during drilling activities in the Chukchi Sea in 2012, 386 or 97 percent, were observed in areas away from the drill site where they would not have been exposed to received sound source levels greater than or equal to 120 dB_{rms}. Of the 396 seals observed, two seals were observed in areas where received sound levels from drilling were greater than or equal to 160 dB_{rms}, and 7 seals were in areas with received sound levels estimated between 120 and 160 dB_{rms} (Bisson et al. 2013).

Based on this information, ringed and bearded seals are likely to be adversely affected through displacement due to drilling and production associated noise.

6.1.1.8 Vessel Noise, Presence, and Strike

As discussed in 2.1.1.1, the Liberty project will use sea-going barges and tugs, coastal barges and tugs, small crew boats, and hovercrafts, during the open-water season throughout the life of the project. Sea-going barges and tugs will transit from Dutch Harbor to either Endicott or West Dock (Figure 6). Coastal barges and tugs, hovercrafts, and small crew boats will travel from West Dock or Endicott SDI to the LDPI (Figure 5). Additionally, a bathymetry vessel will be used annually to inspect the LDPI. Table 3 summarizes the frequency each type of vessel will be used.

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. 1995c, Simmonds et al. 2004). Coastal barges and tugs produce a peak sound source level of approximately 164 dB re 1 μPa_{rms} at 1 m (Richardson et al. 1995c). 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. 1995c) and 149 dB re 1 μPa_{rms} at 1 m (Blackwell and Greene 2005), respectively. As described in Section 2.1.1.1 and Table 18, 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. 1995c).

Auditory or visual disturbance to listed species could occur during all vessel activities. A listed species could react to project activities by either investigating or being startled by vessels. Disturbance from vessels could temporarily increase stress levels or displace an animal from its habitat. Underwater noise from vessels may temporarily disturb or mask communication of marine mammals. Behavioral reactions from vessels can vary depending on the type and speed of the vessel, the spatial relationship between the animal and the vessel, the species, and the behavior of the animal prior to the disturbance from the vessel. Response also varies between individuals of the same species exposed to the same sound. If animals are exposed to vessel noise they may exhibit deflection from the noise source, engage in low level avoidance behavior, exhibit short-term vigilance behavior, or experience and respond to short-term acoustic masking behavior, but these behaviors are not likely to result in significant disruption of normal behavioral patterns. Individual animals' past experiences with vessels appear to be important in determining an individual's response (Shell 2012). Vessels moving at slow speeds and avoiding rapid changes in direction or engine RPM may be tolerated by some species. Other individuals may deflect around vessels and continue on their migratory path.

Bowheads

Bowheads are rarely observed inside of the barrier islands in Foggy Island Bay or the area of the barging route from West Dock or Endicott to the LDPI; therefore, bowheads are most likely to encounter sea-going barges transiting from Dutch Harbor to and from the project area. The number of vessel transits that could expose bowhead whales to strikes is limited to sea-going barges traveling no more than 14 trips per year during construction and decommissioning activities and approximately 2 trips per 5 years during drilling and production (see Section 2.1.1.1; Table 3).

Vessel noise and presence can impact bowhead whales by causing behavioral disturbances, auditory interference, or non-auditory physical and physiological effects (by vessel strike). 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.

Slow moving vessels that are not moving towards bowhead whales do not typically elicit strong reactions (Richardson et al. 1995c). However, during vessel disturbance experiments conducted in the Beaufort Sea, bowhead whales have been documented avoiding vessels approaching rapidly and directly towards them from 1 to 4 km (0.6 to 2.5 mi) away and they moved away at increased speeds when vessels approached closer than 2 km (1.2 mi) (Richardson and Malme 1993, Richardson et al. 1995c). Bowheads first typically try to outswim the approaching vessel. When a vessel is within a few hundred meters, bowhead whales will either remain on course, or turn and swim away perpendicular to the approaching vessel. Bowhead whales typically ceased avoidance measures once the vessel was a few kilometers away and the vessel had passed. Nearby vessel activity temporarily disrupted the whale's activity and sometimes disrupted social groups; however, some whales returned to their original locations (Richardson and Malme 1993).

Whale reactions to vessel presence was also reported by Bisson et al. (2013) where a total of 581 whales were observed during vessel-based monitoring of exploratory drilling activities by Shell in the Chukchi Sea during the 2012 open-water season. Approximately 44 percent of whales exhibited no observable movement or neutral movement relative to moving vessels.

Approximately 47 percent of whales sighted from stationary vessels either did not move or displayed neutral movement relative to the vessel. Swimming away from the moving vessel (18 percent) or stationary vessel (16 percent) was the next most common behavior observed.

Individual bowheads that are sensitive to vessel noise or presence could flee from vessels supporting proposed LDPI construction; based on the observed behavior, they would be expected to stop within minutes after the vessel passed, but could remain scattered for a longer period (Koski and Johnson 1987, Richardson and Malme 1993). Multiple studies have reported that after disturbance and displacement by vessels, bowheads may return to a disturbed area within several days (Koski and Johnson 1987, Thomson and Richardson 1987); however, the impacts of repeated disturbance from vessels on bowhead whale habitat use are less well known. More likely, some whales could exhibit subtle behavioral changes in their surfacing and blow cycles, while others appear to be unaffected. Bowheads actively engaged in social interactions or mating may be less responsive to vessels (MMS 20020).

Acoustic studies at Northstar during the fall of 2001 through 2004 indicate a small number of bowhead whales in the southern portion of the fall migration corridor were affected by industrial noise output by facility activities, which were predominantly vessel noise (Richardson 2008). Although it is not entirely clear whether the whales responded merely by changing calling rates, by deflection, or both, a behavioral response to the anthropogenic noise at Northstar occurred. McDonald et al. (2006a) reported subtle offshore displacement of the southern edge of the bowhead whale migratory corridor offshore from the drilling on Northstar Island. However, subsequent analyses revealed the modification in their migration route was due to environmental conditions, not noise from Northstar, although they reduced their vocalizations until passing west of the island, and a fraction of whales slightly shifted their travel routes to the north in years when noise levels from Northstar were above ambient (Blackwell and Greene 2006, Aerts and Richardson 2009, Richardson et al. 2012).

Bowhead whales are among the slowest moving of whales, which may make them particularly susceptible to ship strikes, although records of strikes on bowhead whales are rare (Laist et al. 2001, George et al. 2017). George et al. (2017) examined records for 904 bowhead whales harvested between 1990 and 2012. Of these, 505 whales were examined for scars from ship strikes including propeller injuries. Only 10 whales harvested between 1990 and 2012 (approximately 2 percent of the total sample) showed clear evidence of scarring from ship propeller injuries. The low number of observations of ship-strike injuries (along with the very long lifespan of these animals) suggests that bowhead whales either do not often encounter vessels or they avoid interactions with vessels.

The probability of strike events depends on the frequency, speed, and route of the marine vessels, as well as distribution and density of marine mammals in the area. Vanderlaan and Taggart (2007) used observations to develop a model of the probability of lethal injury based upon vessel speed. They projected that the chance of lethal injury to a whale struck by a vessel travelling at speeds over 15 knot (28 km/hour) is approximately 80 percent, while for vessels travelling between 8.6 knots (16 km/hour) and 15 knot (28 km/hour), the probability that a struck whale would be lethally injured was about 20 percent. Therefore, with the mitigation measure to reduce vessel speed to less than 5 knots (9 km/hour) within 300 yards (900 ft or 274 m) of the whale(s), the likelihood of injury from a strike from a Liberty project vessel will decrease. A reduction in vessel speed provides vessels and whales more reaction time to avoid strikes, while lessening the potential impact force and trauma severity to whales if a strike were to occur.

Although some bowheads could receive sound levels in exceedance of the acoustic threshold of 120 dB from the tugs during this proposed project, take is unlikely to occur. Vessels for this proposed project are not likely to acoustically harass bowheads, per the Interim Guidance on the ESA term "harass" (Wieting 2016). While bowheads will likely be exposed to acoustic stressors from this proposed project, the duration of the exposure will be temporary, because vessels will be in transit. At 10 knots, vessels will ensonify a given point in space to levels above 120 dB for less than 9 minutes. Because vessels will be emitting continuous sound as they transit through the area, vessel activities will alert bowheads of their presence before the received level of sound exceeds 120 dB (a Level B take threshold). Therefore, a startle response is not expected. Rather deflection and avoidance are expected to be common responses in those instances where there is any response at all. The implementation of mitigation measures is expected to further reduce the significance of bowhead whale reaction to transiting vessels. Consequently, barge traffic is not expected to significantly disrupt normal bowhead behavioral patterns (breeding, feeding, sheltering, resting, migrating, etc.). While a few whales may be exposed to vessel noise, the effects are anticipated to be immeasurably small and not rise to the level of take. Vessel strike is extremely unlikely to occur due to the implementation of mitigation measures.

Ringed and Bearded Seals

Ringed and bearded seals could be encountered during the open water season along the sea-going barge route from Dutch Harbor to the LDPI and within Foggy Island Bay throughout the life of the project. The presence and movements of ships near seals can affect their normal behavior (Jansen et al. 2010). Variables that help determine whether seals are likely to be disturbed by vessels include the number of vessels, the distance between a vessel and a seal, vessel speed and direction, vessel noise, vessel type and/or size, and the behavior of the seal prior to its awareness of the vessel's presence. Vessels associated with the proposed action will produce sound that may elicit behavioral changes in ringed and bearded seals, mask their underwater communications, mask received noises, and cause them to avoid noisy areas. The effects of vessel presence on seals in open water will be temporary and transient in nature as the vessel approaches and passes seals. Increases in ambient noise, however temporary, have the potential to mask communication between mammals (Richardson and Malme 1993), and some marine mammals have been known to alter their own signals to compensate for increased ambient noise levels (Au et al. 1974, Di Lorio and Clark. 2010, BOEM 2017a). Richardson et al. (1995c) found vessel noise does not seem to strongly affect pinnipeds in the water, explaining that seals on haul outs often respond more strongly to the presence of vessels.

During the open water season in the Chukchi Sea, bearded and ringed seals have been commonly observed close to vessels where received sound levels were low (Harris et al. 2001, Moulton and Lawson 2002, Blees et al. 2010, Funk et al. 2010). Funk et al. (2010) noted among vessels operating in the Chukchi Sea where received sound levels were <120 dB, 40 percent of observed seals showed no response to a vessel's presence, slightly more than 40 percent swam away from the vessel, 5 percent swam towards the vessel, and the movements of 13 percent of the seals were unidentifiable. Bisson et al. (2013) reported a total of 938 seals were observed during vessel-based monitoring of exploratory drilling activities by Shell in the Chukchi Sea during the 2012 open water season. The majority of seals (42 percent) responded to moving vessels by looking at the vessel, while the second most noted behavior to moving vessels was no observable reaction (38 percent). The majority of seals (58 percent) showed no reaction to stationary vessels, while looking at the vessel was the second most common behavioral response to a stationary vessel (38 percent). Other common reactions to both moving and stationary vessels included splashing and changing direction.

Evidence suggests that a greater rate of mortality and serious injury to marine mammals correlates with greater vessel speed at the time of a ship strike (Laist et al. 2001, Vanderlaan and Taggart 2007). Most lethal and severe injuries resulting from ship strikes have occurred from vessels travelling at 14 kn or greater (Laist et al. 2001). There is a limited possibility that vessels associated with the proposed action could strike a few seals in open water conditions. However, seals are agile swimmers and would most likely be able to maneuver away from vessels to avoid interactions. There have been no reported vessel strikes of ringed or bearded seals in the Arctic.

Vessel traffic originating from West Dock and the Endicott Causeway has been operating in the nearshore environment of the action area for many years. As such, pinnipeds maybe habituated to the anthropogenic activities. Pre-existing levels of vessel activity have not been shown to adversely affect seals, such as vessel activity associated with the Nikaitchuq offshore drilling site west of Foggy Island Bay in Simpson Lagoon (BOEM 2017a).

Vessel traffic is not expected to significantly disrupt normal pinniped behavioral patterns (breeding, feeding, sheltering, resting, migrating, etc.), because the majority of pinniped/vessel interactions documented during Arctic oil and gas exploration operations in the Chukchi Sea show little to no observable behavioral reactions due to vessels. The implementation of mitigation measures (see Section 2.1.2) is expected to further reduce the significance of ringed and bearded seals reaction to transiting vessels. Therefore, the impact of vessel acoustic and visual harassment is very minor, and thus adverse effects to ringed and bearded seals will be immeasurably small. Furthermore, the probability of a vessel strike occurring is very small, and thus adverse effects to ringed and bearded seals are extremely unlikely to occur.

6.1.1.9 Aircraft Noise

Aircraft operations would support LDPI construction, operations, and decommissioning activities. Section 2.1.1.1 outlines the frequency aircrafts (i.e. helicopters, fixed-winged, and UASs) will be used throughout the life of the project. 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 2012b). 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 et al. 2000, 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. 1995c).

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 Hertz (Hz; (Richardson et al. 1995c). Richardson et al. (1995c) reported that received sound levels in-water from aircraft flying at an altitude of 152 m (approximately 500 ft) were 109 dB re 1 µPa for a Bell 212 helicopter, and 101 dB re 1 µPa for a small fixed-wing aircraft. Noise from aircraft underwater is greatest just below the surface underneath the aircraft. The transmission of noise from an airborne source into the water depends on local conditions, the depth of the receiver, and the bottom depth. Snell's law predicts a critical angle of 13° from the vertical for transmission of sound from air to water (Richardson et al. 1995c). 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.

Except for take-offs, landings, and emergency situations, helicopter and fixed-wing aircraft will travel at an altitude of at least 457 m (1,500 ft). When combining Snell's law of a 26° diameter (13º radius) cone of potential sound propagation below the sea surface and the aircraft altitude of 457 m (1,500 ft), at a single point in time, aircraft noise could propagate into water within a 105 m (346 ft) radius (or 211 m [692 ft] diameter) directly beneath the aircraft at the surface of the water. Thus, given the in-air sound attenuation and the inefficient transference of acoustic energy across the air/water interface, underwater aircraft sound is likely to have an insignificant impact on seals.

Hilcorp plans to use a typical UAS for marine mammal monitoring such as a ScanEagle or Puma AE. The ScanEagle at maximum throttle produces noise levels at 85 to 90 dB re 20 µPa at 6 m (20 ft; Hodgson et al. 2013), which is lower than NMFS's thresholds for in-air sound pressure levels from broadband sounds that cause Level B behavioral disturbance of 100 dB re 20µ Pa rms for non-harbor seal pinnipeds. Additionally, when combining Snell's law of a 26° diameter (13º radius) cone of potential sound propagation below the sea surface and the UAS altitude of 152 m (500 ft), at a single point in time, UAS noise could propagate into water within a 35 m (115 ft) radius (or 70 m [230 ft] diameter) directly beneath the UAS at the surface of the water.

Due to Doppler shifts, the received sound levels within any stationary point will diminish when an aircraft passes overhead. Therefore, aircraft flyovers are heard underwater for a very short duration and are most pronounced as the aircraft approaches or leaves a location. For example, a fixed wing aircraft flying at 152 m (500 ft) altitude at 120 mph (as is likely to be the case for project aircraft during surveys) would ensonify the area of water within the 13º-radius cone near the surface (a 70 m diameter disc at the surface) for a duration of about 1.3 seconds in calm sea conditions. Sound will propagate outwards from that area of ensonified surface water, increasing the total duration of sound at a given point. Aircraft flying at lower altitudes will transmit more intense sound to a smaller sized disc at the water surface. Duration of underwater sound from passing aircraft is much shorter than in air. For example, a helicopter passing at an altitude of 152 m (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. 1995c). The duration of noise from passing fixed-wing aircraft is shorter, because fixed-wing aircraft generally travel faster and are quieter than helicopters.

Sounds from aircraft would not have physical effects on marine mammals, but represent acoustic stimuli (primarily low-frequency sounds from engines and rotors) that have been reported to affect the behavior of some marine mammals.

Bowhead Whales

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

Different aircraft maneuvers can have varying behavioral effects on bowhead whales. Fixed-wing aircraft flying at low altitude often cause bowhead whales to make hasty dives (Richardson and Malme 1993). Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during aerial photogrammetry studies of feeding bowhead whales sometimes caused abrupt turns and hasty dives.

Individual bowhead whales affected by aircraft traffic are expected to exhibit brief behavioral responses. In the Patenaude et al. (2002) study, when bowhead whales did display discernible reactions to aircraft, reactions included abrupt dives, breaching, and short surfacing periods. Helicopters were more likely to elicit responses than fixed-wing aircraft (Patenaude et al. 2002). Patenaude et al. (2002) found that most reactions by bowhead whales to a Bell 212 helicopter occurred when the helicopter was at altitudes of 150 m or less and lateral distances of 250 m or less. The most common reactions were abrupt dives and shortened surface time and most, if not all, reactions seemed brief. However, the majority of bowhead whales showed no obvious reaction to single passes, even at those distances.

Patenaude et al. (1997) found that few bowhead whales (2.2 percent) during the spring migration were observed to react to Twin Otter overflights at altitudes of 60 to 460 m (197 to 1,509 ft). Reaction frequency diminished with increasing lateral distance and with increasing altitude. Most observed reactions by bowhead whales occurred when the Twin Otter was at altitudes of 182 m (597 ft) or less and lateral distances of 250 m (820 ft) or less. There was little, if any, reaction by bowhead whales when the aircraft circled at an altitude of 460 m (1,509 ft) and a radius of 1 km (0.6 mi). From this study it can be concluded that the effects from an aircraft are brief, and the bowhead whales should resume their normal activities within minutes. UASs are not as noisy as fixed-wing and helicopters, so we assume any effects from the use of UAS would be even less than the already minor effects from other aircraft.

Given that bowhead whales are rarely observed within the barrier island and along the aircraft flight path from Prudhoe Bay to LDPI and given the implementation of mitigation measures (see Section 2.1.2), the probability of aircraft traffic (fixed-wing, helicopters, and UAS) disturbing a bowhead whale is very small, and thus adverse effects to bowhead whales are extremely unlikely to occur. Additionally, given the short duration of exposure to aircrafts and the limited reactions bowhead whales have had to aircraft, if a bowhead whale is exposed to aircraft the impact is very minor, and thus adverse effects to bowhead whales will be immeasurably small. Therefore, we conclude that the adverse effects from air traffic associated with the Liberty project on bowhead whales is insignificant and discountable.

Ringed and Bearded Seals

Ringed and bearded seals maybe disturbed year-round from aircraft flying to and from the LDPI; however, presence of bearded seals during the winter months is expected to be minimal (Section 4.1.5). Most studies have analyzed the effects of aircraft on ringed seals. Bearded seals are expected to elicit similar responses to aircraft as ringed seals unless otherwise noted. Ringed seals have displayed various responses to aircraft (Kelly et al. 1986). Aircraft noise may directly affect seals which are hauled out on ice during molting or pupping; however, the presence of snow cover above seal lairs will reduce the received levels of airborne sound for seals inside lairs (Holliday et al. 1983, Cummings et al. 1986, Kelly et al. 1986). Richardson et al. (1995c) noted pinnipeds hauled out for pupping or molting are the most responsive to aircraft. Other authors noted ringed seals responses to aircraft are variable, depending on the time of year and environmental conditions (Burns and Harbo 1972, Burns and Frost 1979, Alliston 1981, Burns et al. 1982).

Born et al. (1999) indicated that the disturbance of hauled out ringed seals can be substantially reduced if a small helicopter does not approach ringed seals closer than 1,500 m. There are reports of seals habituating to frequent over flights to the point where there was no reaction. Richardson et al. (1995c) and Hoover (1988) did not attribute seal pup mortality to low-flying aircraft, noting a temporary avoidance behavior reaction to aircraft as close as 76 m. A greater number of ringed seals responded to helicopter presence than to fixed-wing aircraft presence, and at greater distances (up to 2.3 km [1.4 mi] from the aircraft), suggesting sound stimuli trigger escape responses in ringed seal (Smith and Hammill 1981, Born et al. 1999). Kelly et al. (1986) also reported ringed seals leaving the ice when a helicopter was within 2 km (1.2 mi), flying below 305 m (1,000 ft) altitude. However, escape responses are not elicited consistently (Richardson et al. 1995c).

Born et al. (1999) reported that the probability of hauled out ringed seals responding to aircraft overflights with escape responses was greatest at lateral distances of less than 200 m (600 ft) and overhead distances less than 150 m (~450 ft). Individual bearded seals have been documented exhibiting escape reactions when approached by aircraft (Burns and Harbo 1972, Richardson et al. 1995c). Born et al. (1999) also reported ringed seals showed a 21 percent probability of fleeing from fixed wing aircraft at 100 m from the aircraft, 6 percent between 100 and 300 m from the flight track, and 2 percent between 300 and 500 m from the flight track. There was no specific study for Northstar operations that documented seal reactions to aircraft; however, incidental observations documented that most seals near Northstar reacted briefly and mildly when a helicopter arrived on the island. Less than 2 percent of seals reacted by diving to fixed-wing aircraft flying at 91 m (300 ft) during aerial surveys conducted in the late ice-covered season (Richardson 2008). Blackwell et al. (2004a) documented that 92 percent (11 of 12) ringed seals reacted to low-flying helicopter operations; however, these reactions were not strong or long lasting, with only 8 percent (1 of 12) seals returning to the water. The remaining 10 seals increased their vigilance and looked at the helicopter (Blackwell et al. 2004a).

Given the short duration of exposure of aircrafts and the altitude of 1,500 ft helicopters and fixed wing will travel (along with additional mitigation measures; see Section 2.1.2), and the small ensonified area for UAS, we conclude that the probability of aircraft traffic disturbing ringed and bearded seals is very small, and thus adverse effects to these species are extremely unlikely to occur. Additionally, since seal reactions have previously been documented as temporary and aircraft exposure would be limited in duration, we conclude that if ringed and bearded seals are exposed to aircraft the impact is expected to be very minor, and thus adverse effects to these species will be immeasurably small. Therefore, we conclude that the adverse effects from aircraft associated with the Liberty project (fixed-wing, helicopters, and UAS) on ringed and bearded seals is insignificant and discountable.

6.1.2 Other Noise Sources

Hilcorp will conduct annual inspections of the island slope through topographic and bathymetric surveys or periodic shallow geophysical or geohazard surveys to identify potentially hazardous conditions at or below the seafloor (see Section 2.1.1.6).

Typical types of equipment and acoustic sources used for annual inspections or geohazard surveys include side scan sonar system that operates at 194 to 249 dB re 1 µPa at 1 m between 100 and 1,600 kHz; single-beam echosounder that operates at a frequency of 210 kHz with a source level of 108 to 205 dB re 1 µPa at 1 m; and multi-beam echosounder with a source level between 216 to 242 dB re 1 µPa at 1 m and operating frequencies between 180-500 kHz.

Bowhead Whales, Ringed Seals, and Bearded Seals

It is extremely unlikely that the acoustic devices with operating frequencies between 100 and 1,600 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 bowheads (i.e., between 7 Hz and 25 kHz) and seals (i.e., between 50 Hz and 86 kHz). In the unlikely event that these acoustic devices operating between 100 to 1,600 kHz are audible to ESA-listed whales and seals, 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 to occur.

For these reasons (i.e., inaudibility and spatially limited exposure area), we conclude the effects from side scan sonar and from single-beam and multi-beam echosounders on listed marine mammals are extremely unlikely to occur, and are therefore considered discountable.

6.1.3 Habitat Alteration

As discussed in Section 2.1.1.2, the Liberty Project will include building an artificial gravel island constructed in 19 ft (5.8 m) of water in Foggy Island Bay of the Beaufort Sea. The Liberty Project will be removing approximately 24 ac (9.7 ha) of habitat for ESA-listed species. ESA-listed species could also be affected by temporary habitat alteration from the construction of ice roads or the installation of the pipeline, and impacts from temporary habitat alterations associated with these stressors are discussed in Sections 6.2.1.5 and 6.2.1.6, respectively.

Bowhead Whales

Since bowhead whales are rarely observed shoreward of the barrier islands where the gravel island will be located, it is unlikely that this habitat is important to bowhead whales. Bowhead whales are unlikely to notice the presence of an artificial gravel island. The impact of habitat alteration is very minor, and thus adverse effects to bowhead whales will be immeasurably small. Therefore, we conclude that the adverse effects from habitat alteration on bowhead whales are insignificant.

Ringed and Bearded Seals

Ringed and bearded seals are regularly documented near the location of the LDPI. However, the amount of habitat reduced by the placement of the gravel (covering 24 acres) is extremely small compared to the amount of habitat available in Foggy Island Bay and the Beaufort Sea. The impact of habitat alteration is expected to be minor, and thus adverse effects to ringed and bearded seals will be immeasurably small. Therefore, we conclude that the adverse effects from habitat alteration on these species are insignificant.

6.1.4 Authorized Discharges

Marine mammals could be exposed to authorized discharges through marine vessels carrying project materials from Dutch Harbor to the LDPI or from discharges at the LDPI (Section 2.1.1.6). Discharges associated with some marine commercial vessels are covered under a national NPDES Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels. Commercial vessels are covered under the VGP when discharging within the territorial sea extending three nautical miles from shore. When vessels are operating and discharging in Federal waters the discharges are regulated under MARPOL 73/78 the International Convention for the Prevention of Pollution from Ships. The EPA completes consultation on the issuance of the VGP permit with the Services and receives separate biological opinions. Previously, these opinions have concluded that EPA's issuance of the VGP was not likely to jeopardize listed or proposed species or adversely modify designated or proposed critical habitat. Since ESA consultation was successfully completed on this general permit, impacts associated with marine vessel discharges have already been considered and any incidental take accounted for previously.

As previously discussed, Hilcorp has requested authorization to discharge five waste streams from LDPI, four of which will be contingency discharges that will be intermittent, short term, and low volume (sanitary and domestic wastewater, potable water treatment reject wastewater, construction dewatering wastewater, and secondary containment dewatering wastewater). Only one discharge (seawater treatment plant wastewater) will be ongoing. The majority of the five discharges are anticipated to be infrequent (twice per year) when the disposal well is undergoing mechanical integrity testing and or maintenance, likely in the summer. These discharges would be most likely be the sanitary and domestic wastewater, potable water treatment reject wastewater, and seawater treatment plant wastewater (which is ongoing). The majority of pollutants (up to 99 percent) are removed from the sanitary and domestic wastewater. The primary pollutants in the other two waste streams are total suspended solids, temperature, and total residual chlorine. The effluent concentration of total suspended solids is predicted to be 130 milligrams per liter; temperatures are anticipated to be maximum of 25°C in winter and 30°C in summer; and the total residual chlorine concentration is estimated to be less than 1 ppm.

Bowhead Whales

The potential for authorized discharges to impact bowhead whales depends on the likelihood of exposure of the species. As discussed in Section 4.1.3, bowheads are rarely observed within the barrier islands. Of the five discharges, only the seawater treatment plant discharge is continuous and of a volume (0.94 million gallons per day) that could result in a plume that would be transported for a significant distance and still potentially be detected by bowhead whales. Bowhead whales would need to be swimming sufficiently close to the LDPI to encounter the discharges. Given that few bowhead whales have been documented in the vicinity of the LDPI, it is unlikely that they would encounter elevated total suspended solids in a plume that originated from the LPDI and at a concentration that would elicit a response.

It is unlikely that bowhead whales will be exposed to authorized discharges for the following reasons: bowhead whales have rarely been documented within the vicinity of the LDPI; four of the permitted discharges are expected to be of short duration during planned events (two-days twice a year) and infrequent (one unplanned event [two weeks] over the permit term [5 years]); pollutant loading is minimized using membrane bioreactor technology and ultraviolet disinfection which are designed to remove up to 99 percent of pollutants in the sanitary and domestic wastewater; all pollutants must meet effluent limitations at the "end-of-pipe," and no mixing zone is authorized; and Hilcorp will attempt to store wastes during testing and maintenance (planned event) when the disposal well is offline. Therefore, we anticipate that effects from authorized discharges to bowhead whales are extremely unlikely to occur (i.e., bowhead are rarely seen, and there are only a few discharge events), and would be discountable.

Ringed and Bearded Seals

Ringed and bearded seals may be exposed to authorized discharges depending on their use of the habitat in the action area at the time of discharge. If seals are in the action area when the disposal well is offline for a planned (two days, twice a year) or unplanned event (two weeks with the NPDES permit term) and when the seawater treatment plant discharges are occurring (after year 2 of construction), they may be exposed to pollutants in the discharge.

If discharges occur during the winter months it is extremely unlikely that bearded seals will be exposed as their density during the ice covered season is extremely low. However, if ringed seals are present during the winter, or if ringed or bearded seals are present during the summer and their presence coincides with a contingency discharge or an unplanned event, then they may be exposed to a discharge for all or some of the time during these discharges.

The seawater treatment plant wastewater discharge is ongoing and if seals were to encounter the plume within 100 m^2 (1,076 ft^2) from the point of discharge they could encounter a localized area of elevated total suspended solids and brine. Suspended solids vary widely in the Beaufort Sea due to hydrodynamics and freshwater inputs; therefore seals maybe accustomed to ranges of total suspended solids (BOEM 2017a). At the same time, the discharge could cause the seals to avoid the area of the discharge plume.

The discharges are not expected to affect food availability due to the removal of pollutants from the discharges (including bioaccumulative chemicals) using the membrane bioreactor and permit requirements which avoid and minimize the discharge of petroleum products and other pollutants. Additionally, prey species such as Arctic cod have a very broad distribution, and ringed and bearded seals can forage over large areas of the Beaufort Sea and do not exclusively rely on local prey abundance in open water conditions.

Considering the low density of ringed and bearded seals in the action area and the limited duration of potential contingent discharges (one unplanned event for two-weeks during the 5-year NPDES permit term and two days of discharge twice per year), the probability of authorized discharge associated with the Liberty Project impacting ringed and bearded seals is small and thus adverse effect to these species are extremely unlikely to occur. If ringed and bearded seals are exposed to authorized ongoing or contingent discharges, the impact will be very minor because pollutants are reduced by 99 percent in the sanitary and domestic wastewater by using membrane bioreactor technology and ultraviolet disinfection, and all pollutants must meet effluent limitations stipulated in the NPDES permit at the “end-of-pipe” (because no mixing zone is authorized); thus, adverse effects to ringed and bearded seals will be immeasurably small. Therefore, we conclude that the adverse effects from authorized discharges on ringed and bearded seals are insignificant and discountable.

6.1.5 Oil and Gas Spills, Drills, and Response

6.1.5.1 Accidental Oil Spill Releases

Based on BOEM/BSEE’s oil spill analyses, the only sized spills that are reasonably likely to occur in association with the proposed action are small spills (<1,000 bbls) (BOEM 2017a).

Accidental oil spills have a varying potential to occur. Accidental oil spills or gas releases may potentially affect listed species during all phases of the proposed action, depending on the spill type, source, and size (volume).

Small Spills

Small spills are defined as spills of less than 1,000 bbls, and a large spill is greater than 1,000 bbls. Small spills, although accidental, occur during oil and gas activities with generally routine frequency and are considered likely to occur during development, production, and/or decommissioning activities associated with the proposed action. The majority of small spills would be contained on the proposed LDPI or landfast ice (during winter). BOEM anticipates that small refined spills that reach the open water would be contained by booms or absorbent pads; these small spills would also evaporate and disperse within hours to a few days. A 3 bbl refined oil spill during summer is anticipated to evaporate and disperse within 24 hours, and a 200 bbl refined oil spill during summer is anticipated to evaporate and disperse within 3 days (BOEM 2017a).

BOEM estimates about 70 small spills, most of which would be less than 10 bbls, would occur over the life of the Liberty Project. Small crude oil spills would not likely occur before drilling operations begin. Small refined oil spills may occur during development, production, and decommissioning. The majority of small spills are likely to occur during the approximate 22-year production period, which is an average of about 3 spills per year. Table 24 outlines the estimated total and annual number and volume of small refined oil spills.

Table 24. Total and annual potential small oil spills in barrels (bbl) throughout the life of the project (BOEM 2017a).

Estimated Total Spills	Estimated Total Volume	Average Annual Spills	Average Annual Volume
0 to 70	0 to 196 bbl	0 to 3	0 to 9 bbl
Note: Table represents the estimated number and volume of small crude or refined oil spills by total and annual average during development, production, and decommissioning.			

Large Spills

A large spill is a statistically unlikely event. The average number of large spills for the proposed action was calculated by multiplying the spill rate (Bercha International Inc. 2016, BOEM 2017a), by the estimated barrels produced (0.11779 Bbbl or 117.79 Million Barrels). By adding the mean number of large spills from the proposed LDPI and wells (~0.0043) and from pipelines (~0.0024), a mean total of 0.0067 large spills were calculated for the proposed action. Based on the mean spill number, a Poisson distribution indicates there is a 99.33 percent chance that no large spill occurs over the development and production phases of the project, and a 0.67 percent chance of one or more large spills occurring over the same period. The statistical distribution of large spills and gas releases shows that it is much more likely that no large spills or releases occur than that one or more occur over the life of the project. However, a large spill has the potential to seriously harm ESA-listed species and their environment. Assuming one large spill occurs instead of zero allows BOEM to more fully estimate and describe potential environmental effects (BOEM 2017a).

One large spill of crude or refined oil is assumed to occur during the development or the production phases, which BOEM predicts could be an island large spill or a pipeline large spill, and either a pipeline leak or a pipeline rupture. The large OCS spill-size assumptions BOEM uses for a spill from the island and an offshore pipeline leak are based on reported spills in the Gulf of Mexico and Pacific OCS because no large spills (≥1,000 bbl) have occurred on the Alaska or Atlantic OCS from oil and gas activities. BOEM uses the median OCS spill size as the likely large spill size (Anderson et al. 2012) because it is the most probable size for that spill-size category. The Gulf of Mexico and Pacific OCS data show that a large spill most likely would be from a pipeline or a platform. The median size of a crude oil spill ≥1,000 bbl from a pipeline on the OCS from 1996-2010 is 1,720 bbl, and the average is 2,771 bbl (Anderson et al. 2012). The median spill size for a platform on the OCS over the entire record from 1964-2010 is 5,066 bbl, and the average is 395,500 bbl (Anderson et al. 2012). Outliers such as the Deepwater Horizon (DWH) spill volume skew the average, and thus the average is not a useful statistical measure. For purposes of this analysis, BOEM uses the median spill sizes for OCS pipelines and platforms, rounded to the nearest hundred shown below, as the likely large spill sizes for an offshore pipeline leak and island spill in the proposed action. The large OCS offshore pipeline spill size due to a rupture is based on the operator’s estimate of a worst-case discharge from its pipeline, 3,979 bbl (Hilcorp 2017), and rounded to the nearest hundred yielding 5,000 bbl (BOEM 2017a) (see Table 26). The Hazardous Liquid Accident Data (2004-2013) was analyzed to estimate crude-oil spills ≥ 1,000 bbl for onshore pipelines (BOEM 2017a).

The spill sizes and types assumed in the analysis are based on the median spill sizes for each type of spill in the historical record and on operator provided spill volume estimates (see Table 27).

Table 25. Large OCS Spill-Size Assumptions in Barrels (BOEM 2017c).

OCS Offshore Pipeline Leak	OCS Offshore Pipeline Rupture	OCS Island Spill
1,700	5,000	5,100

BOEM analyzed the potential for a small and large oil spill based on technical information, historic data, modeling results, statistical analysis, professional judgment, and specific information outlines in the 2015 Liberty DPP (BOEM 2017a). A detailed description of this analysis can be found in Appendix A of the Liberty Draft EIS (BOEM 2017b). Table 27 outlines the assumptions used to analyze the potential effects on ESA-listed marine mammals.

Based on the localized nature of small oil spills, the relatively rapid weathering expected for less than 1,000 bbl of refined oil, and the safeguards in place to avoid and minimize oil spills, the likelihood of a small spill affecting ESA-listed marine mammals in the action area is low. Large or very large spills are not reasonably likely to occur. If the stressor and species are not anticipated to overlap in time and space, then we would not anticipate that ESA-listed would be exposed to large or very large oil spills. However, an analysis of potential impacts on marine mammals is described below.

Very Large Oil Spill

A subset of large spills is the VLOS which is sometimes also called a Catastrophic Discharge Event. For the 2017-2022 Five-Year Program Final Preliminary EIS (BOEM 2016c), BOEM defined a reasonable range of potentially catastrophic OCS spill sizes by applying extreme value statistics to historical OCS spill data (Ji et al. 2014, BOEM 2017a). Extreme value statistical methods and complimentary methods (BOEM 2017a) were used to quantify the potential frequency of different size spills (BOEM 2016c). In combining the per well spill frequency with the number of wells, no VLOS are estimated to occur over the life of the Liberty project.

With the exception of rare events, such as the 2010 DWH explosion, the number of spills and the volume of oil entering the environment from accidental spills have been decreasing in recent decades, even as petroleum consumption has risen (Anderson et al. 2012, Conti et al. 2014). The Deepwater Horizon event is considered a low-probability, high-impact event, and a spill of this volume is highly unlikely to occur during any activity phase; however, if one did occur (as the DWH event), the impacts would be major.

The conditions in the waters at the DWH spill site differ markedly from the conditions present at the Liberty project. The DWH oil spill release occurred in at a depth of 1,500 m (4,921 ft); the proposed action is to drill from the surface of a gravel island in 5.8 m (19 ft) of water. Oil from the hypothetical VLOS would enter the marine environment from the sea surface. This depth difference is important given how gas and liquids behave differently at various pressures, with more gas staying in solution at greater depths. A greater depth may also present a greater likelihood that distinct density layers and currents that could entrain and transport hydrocarbons. Differences between the Gulf of Mexico and the Beaufort Sea in seasonality, weather and wind patterns, and sea ice make extrapolations from the *Deepwater Horizon* Oil Spill release and a hypothetical release in the Beaufort Sea problematic (BOEM 2017b).

Water temperatures in the shallow Beaufort Sea are similar to the temperatures in the deep water Gulf of Mexico, suggesting the Beaufort Sea could support similar levels of hydrocarbon (including methane) degradation. Both methane and petroleum hydrocarbon degraders are present and active in the ice, water, and sediment in the Arctic Ocean in general (BOEM 2017b).

In the Liberty EIS, Section 4.5, BOEM addresses the possibility of a VLOS occurring and uses historic data to assess the likelihood of a VLOS occurring. In the Liberty EIS Section 4.7, BOEM analyzes the potential environmental effects of such an event.

Effects of oil are based on its chemical composition. Likewise, the composition of crude oil determines its behavior in the marine environment (Geraci and St. Aubin 1990a). Weathering (spreading, evaporating, dispersing, emulsifying, degrading, oxidizing, dissolution: Figure 39) and aging processes can alter the chemical and physical characteristics of crude oil. The environment in which a spill occurs, such as the water surface or subsurface, spring ice overflow, summer open-water, winter under ice, winter on ice, or winter broken ice, will affect how the spill behaves. In ice-covered waters many of the same weathering processes occur; however, the sea ice and cold temperatures change the rates and relative importance of these processes (Payne et al. 1991, NRC 2014).

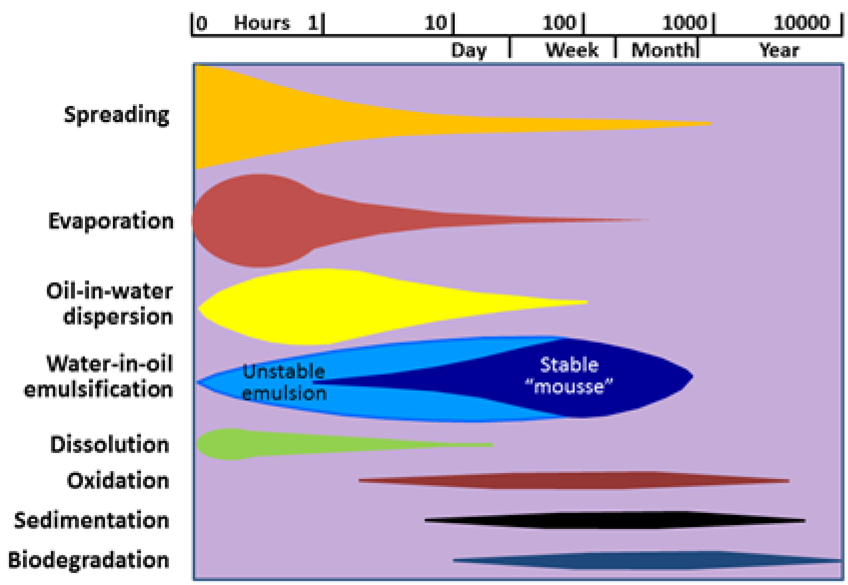


Figure 39. Schematic showing the relative importance of weathering processes of an oil slick over time (Brandvik et al. 2010). The width of the line shows the relative magnitude of the process in relation to other contemporary processes.

Oil released at or near the surface will immediately begin to spread, or drift, horizontally in an elongated shape driven by wind and surface water currents (Elliott et al. 1986). If released below the water, oil will travel through the water column before it forms an oil slick at the surface. The rate of spreading is positively associated with increased temperature and wave action (Geraci and St. Aubin 1990a). Oil spills in the cooler waters are expected to spread less and remain thicker than in temperate waters due to increased viscosity of oil in colder temperatures (NRC 2014). The leading edge of the slick is typically thicker than the interior (Fannelop and Waldman 1972). The thicker oil tends to form patches that move downwind faster than the thinner part of the slick, eventually leaving it behind (Geraci and St. Aubin 1990a).

In increasing ice conditions spilled oil would be bound up in the ice, pumped to the surface by wind/wave action, or encapsulated in pack ice. In spring, the unweathered oil would melt out of the ice at different rates and locations.

Table 26. Oil spill assumptions used for analysis.

Variable	Small Spill (<1,000bbls)	Large Spill Assumption (>1,000 bbls)
Probability and Number of Spills/Release	70 total over the life of the project, rounded to the nearest whole number and inclusive of spills in which the spill volumes are greater than 1 bbl and less than 1,000 bbl. A subset of small spills less than or equal to 1 bbl can also occur.	99.33% chance no large spills occurring; 0.67% chance of one or more large spills occurring. For analytic purposes, we assumed 1 large spill would occur during development and production from either the proposed LDPI or offshore pipeline or onshore pipeline.
Timing	Small refined and crude oil spills during development, production, and decommissioning activities and could occur any time of the year.	A large spill could occur any time of the year. A large crude oil spill could occur during the development (drilling) or production phases. A large diesel spill could occur from the proposed LDPI during development or production.
Sizes and Oil Type	During development, production, and decommissioning, most spills would be 2-3 bbl. 58 spills would be >1 bbl and ≤10 bbl 11 spills would be >10 bbl and ≤200 bbl 1 spill would be >200 bbl and <1000 bbl	Offshore Pipeline (5,000 bbl crude oil rupture or 1,700 bbl crude oil leak), Onshore Pipeline (2,500 bbl crude oil spill), or proposed LDPI (5,100 bbl crude oil or diesel spill).
Medium Potentially Affected	• Air • LDPI • Open water • Broken ice • On top of or under solid ice • Shoreline • Tundra or snow • Ice road • Freshwater systems	• Air • LDPI • Open water • Broken ice • On top of or under solid ice • Shoreline • Tundra or snow
Weathering	A 3 bbl refined oil spill during summer evaporates and disperses within 24 hours. A 200 bbl refined oil spill during summer evaporates and disperses within 3 days.	Diesel oil spill: A 5,100 bbl diesel oil spill will evaporate and disperse much more rapidly than crude oil, generally within 1-30 days. Crude oil spill: After 30 days in open water or broken ice, of the 5,100 bbl of crude oil spill 16.5-17.2% evaporates, 3.3-56.1% disperses, and 26.7-80.2% remains.
Source: (Robertson et al. 2013, BOEM 2016c, 2017b, a)		

Oil Weathering and Spill Trajectory Analyses

BOEM uses the SINTEF oil weathering model (OWM) to perform oil weathering simulations. For the Liberty action area, BOEM assumes open water is July through October, and meltout can occur from June through July. BOEM models both the open water and melt out at different times, BOEM conservatively assumed all the oil was released at the same time. BOEM assumes the spill starts at the surface or quickly rises to the surface in the shallow waters of the Liberty project action area (including the island and the offshore pipeline). For open water, BOEM models the weathering of the spills as if they are instantaneous spills. For the broken ice spill scenario, BOEM models the entire spill volume as an instantaneous spill. Although different amounts of oil could melt out at different times, BOEM took the conservative approach, which was to assume all the oil was released at the same time (BOEM 2017b).

BOEM studies demonstrate how and where large offshore spills move by using an oil-spill trajectory model, known as the OSRA model, which calculates the probability of oil-spill contact (conditional probabilities) and occurrence and contact (combined probabilities) to environmental resource areas (ERAs). In this approach, BOEM simulated large spills originating from one of four Launch Areas and six Pipeline Segments. Map A-6 of the EIS shows a zoomed in view of A-5 along with the launch points that make up the launch areas on the Liberty Island and pipeline (BOEM 2017b). BOEM uses the results of 32,400 trajectory simulations to calculate conditional probabilities (the “estimated percent chance”) that a large spill from one of these areas would contact certain resources or shorelines in Foggy Island Bay and the surrounding region (BOEM 2017b).

Large and Very Large Gas Releases

Unlike in the Cook Inlet Lease Sale 244 EIS (BOEM 2016a), a well control incident resulting in a gas release was not analyzed in the Liberty EIS (BOEM 2017b) or associated permitting documents since Hilcorp’s proposed action does not include natural gas development via dedicated gas production wells. In addition there will be no gas transmission lines associated with the project (BOEM 2018a).

Free gas was not encountered in previous Liberty exploration wells, but the oil in the Liberty reservoir is near the pressure where free gas may be released from solution in the de-pressurized oil upon release. In addition, fluid studies conducted by Hilcorp (and/or previous operators) suggest that a small gas cap could exist in the shallowest part of the oil pool. However, geological studies by BOEM do not detect the presence of free gas in this part of the Liberty reservoir (BOEM 2018a).

BOEM assumes that if a small, unrecognized gas accumulation exists in the Liberty reservoir, it would be located at the shallowest subsurface elevation and no oil production or gas/water injection wells are proposed to target that area of the reservoir. Instead, the development proposal aims to target multiple locations within the oil-bearing zone of the reservoir (Hilcorp 2018a). In line with Hilcorp’s proposal, BOEM did assess an oil-associated gas release in the Liberty EIS (BOEM 2016a; see Section 4.5.6) by reference to the VLOS model adopted for the Beaufort Sea Planning Area (BOEM 2018a).

The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. BOEM makes general assumptions about a hypothetical gas release as a result of a VLOS in the proposed action. The oil in the hypothetical VLOS scenario is assumed to have a gas-oil ratio (GOR) of ~927 scf/bbl, which BOEM estimated by dividing the first day gas volume of 84,538,512 scf by the first day oil volume of 91,219 bbl. Hilcorp (2015; Section 14.3) provides first day discharge volumes. For the hypothetical gas release volume to analyze, BOEM uses the estimated cumulative gas discharge volume over the VLOS duration of 90 days as the hypothetical gas release volume to analyze. The cumulative gas discharge over the 90-day spill period is estimated by multiplying the assumed GOR of 927 scf/bbl by the VLOS volume of 4.61 Mbbl yielding 4.27 Bcf (billion cubic feet) of gas. This estimate uses a simplifying assumption that the GOR remains constant over the 90 day VLOS spill period (BOEM 2016a).

Gas Release Fate

Natural gas is primarily made of up methane CH_4 and ethane C_2H_6, which make up 85-90% of the volume of the mixture. Propane, butane, and heavier hydrocarbons can be extracted from the gas system and liquefied for transportation and storage. These natural gas products are commonly known as liquid petroleum gas or LPG. Pentanes through decane are the intermediate-weight hydrocarbons and are volatile liquids at atmospheric temperature and pressure. The common names for these natural gas products are pentanes-plus, condensate, natural gasoline, and natural gas liquids. Gas associated with the proposed action is expected to be oil-associated and not dry gas.

In the event of a VLOS, any gas release would be almost entirely vapor, rather than liquid. Winter temperatures could cause the butane and pentane components to initially remain in a liquid state. However, if any liquids formed, much of the volume would quickly evaporate due to the volatile nature of natural gas liquids. The consequences of an accidental VLOS could include fire and/or explosion of vapors from natural gas liquids.

The primary component of natural gas is methane, a colorless, odorless, and tasteless gas. It is not toxic in the atmosphere, but is classified as a simple asphyxiate, possessing an inhalation hazard. As with all hydrocarbon gases, if inhaled in high enough concentration, oxygen deficiency could occur and result in suffocation. The specific gravity of methane is 0.55 (Air = 1.0). Being lighter than ambient air, it has the tendency to rise and dissipate into the atmosphere, rather than settle into low areas. For this reason, natural gas leaks are assumed to rise and disperse (BOEM 2016a).

Effects from Oil Spills and Gas Releases

While marine mammals may show irritation, annoyance, or distress from oil, for the most part, an animal's need to remain in an area for food, shelter, or other biological requirements overrides any avoidance behaviors to oil (Vos et al. 2003). In addition, depending on the location of a spill, highly populated areas would be more susceptible than sparsely populated areas. Animals can be affected outside of a main spill area through oil transported by currents and oiled prey (Figure 40). The exposure to oil needs to be in sufficient quantity to produce adverse effects from either external oiling, internal absorption from ingestion of oil and prey, aspiration of oil, inhalation of volatile vapors in the air, and/or a combination of the above.

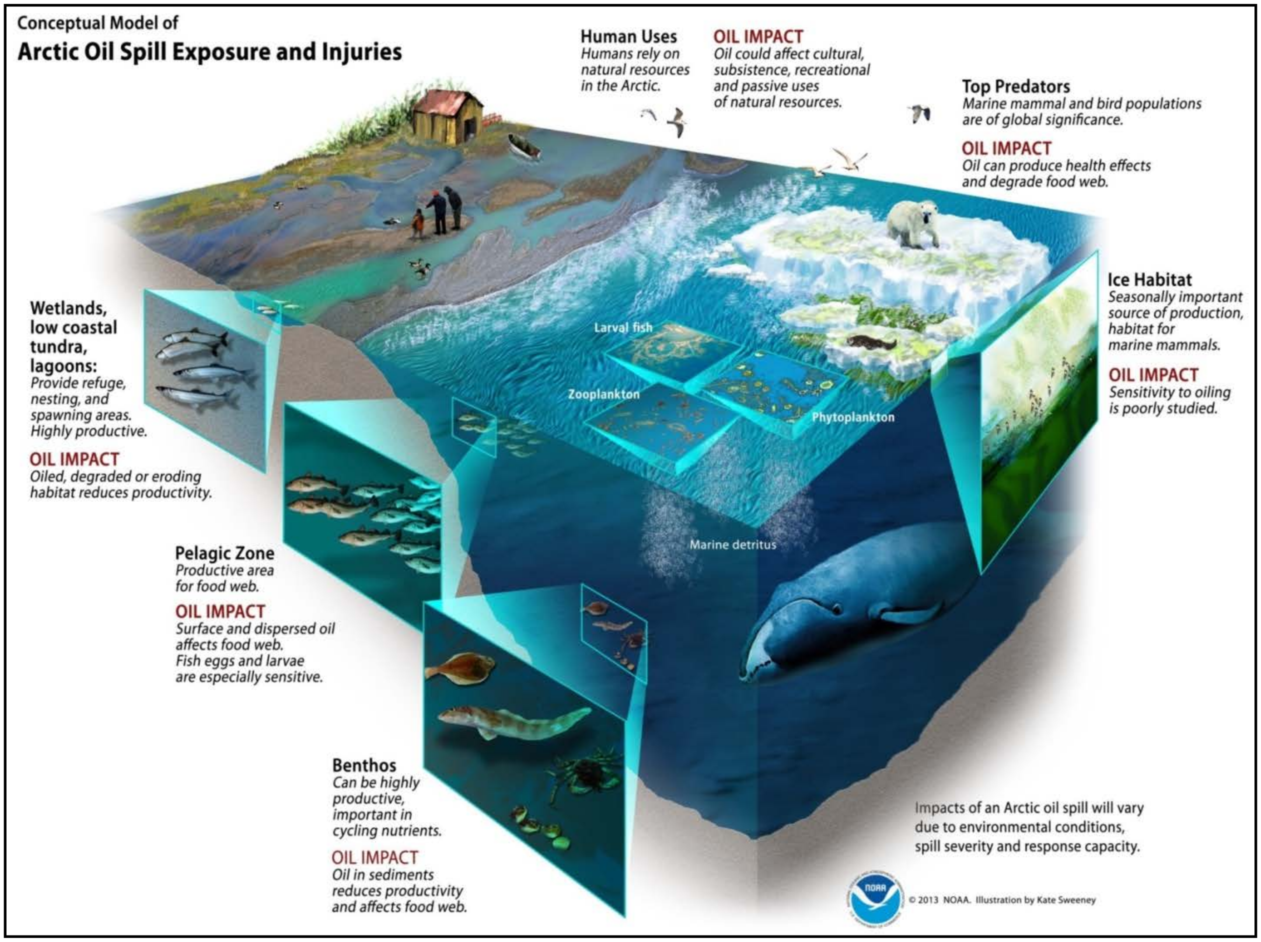


Figure 40. Conceptual model of the various pathways by which marine predators and their prey can be exposed to spilled oil.

In the following sections on anticipated oil spill exposures and response to listed species we qualitatively describe the potential for exposure and response to listed species. This is due to the fact that we have estimates of likelihood of the various sized oil spills occurring, but we do not have estimates on the potential for overlap between spills and listed species.

The primary potential effects to marine mammals from accidental oil spills include: 1) fouling of individuals (including fur and baleen), 2) ingestion/inhalation of oil, 3) habitat/prey degradation, and 4) disruption of migration. Disruption of other essential behaviors, such as breeding, communication, and feeding, may also occur (BOEM 2017b).

Bowhead Whales

Small refined oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation, and residual components rapidly disperse in open waters. Given the low density of bowhead whales near the LDPI (Section 4.1.3), the potential for exposure and response to small oils spills is small. If individual bowhead whales are exposed to small spills, the spills would likely have minimal effects on their health due to small spills sizes, weathering, and rapid spill dispersal.

During the proposed action, up to 70 small oil spills are anticipated. If an individual whale came in direct contact with spilled oil in offshore waters it could experience inhalation and respiratory distress from hydrocarbon vapors, and less likely skin and conjunctive tissue irritation. Substantial injury and mortality due to physical contact inhalation and ingestion is possible; however, this is not likely with a small spill in Foggy Island Bay due to the small spill size, rapid dispersion, and evaporation, as well as the propensity for oil to not adhere to cetacean skin (BOEM 2017a). Depending on the spill location and timing, a small refined spill in offshore waters could evaporate and disperse in 24-36 hours (BOEM 2017a).

A small fuel spill would be localized and would not permanently affect whale prey populations (e.g., forage fish and zooplankton). The amount of zooplankton and other prey lost in such a spill likely would be undetectable compared to what is available on the whales' summer feeding grounds (BOEM 2017a). NMFS does not expect small spills of refined fuels at the rates predicted by BOEM to expose whales or their prey to a measureable level.

Most gas escaping and contacting water would dissipate quickly, likely resulting in no large-scale effects on marine mammals, although some marine mammals in the immediate vicinity of a large natural gas release could be exposed to toxins and die before the gas could volatize. A gas release is expected to have negligible to minor effects on marine mammals (BOEM 2016a).

Depending on the timing, size, and duration of a large spill (greater than 1,000 bbl), bowhead whales could experience contact with fresh oil during summer and/or fall feeding events and migration. Skin and eye contact with oil could cause irritation and various skin disorders. Toxic aromatic hydrocarbon vapors are associated with fresh oil. The rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh oil and disturbance from response related noise and activity could limit the potential exposure of whales to prolonged inhalation of toxic fumes. Exposure of whales to toxic vapors, especially if calves are present, could result in mortality. Surface feeding whales could ingest surface and near-surface oil fractions with their prey, which may also be contaminated with oil components. Incidental ingestion of oil factions that may be incorporated into benthic sediments can also occur during near-bottom feeding. To the extent that ingestion of crude oil affected the weight or condition of the mother, the dependent young could also be affected. Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to accumulate high levels of fat to survive their environment. Ingestion of oil may result in temporary and permanent damage to whale endocrine function and reproductive system function; and if sufficient amounts of oil are ingested, mortality of individuals may also occur.

Bowhead whales are most vulnerable to large oil spills during their westward migration in the fall. A winter spill, or if oil persists in ice over winter, could impact bowheads if oil travelled outside of the barrier islands during the spring break up. Exposure to aged winter spill oil (which has had a portion or all of the toxic aromatic compounds dissipated into the atmosphere through the dynamic open water and ice activity in the polynya) presents a much reduced toxic inhalation hazard. It is possible that a winter spill would result in a situation where toxic aromatic hydrocarbons would be trapped in ice for the winter period and released in toxic amounts in the spring. Calves could be more vulnerable than adults to vapors from a spill because they take more breaths than do their mothers and spend more time at the surface. If a VLOS were to occur during a time when many bowhead 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.

We anticipate that if a VLOS were to occur, the magnitude of the resulting impact could be high because a large number of whales could be impacted. The duration of impacts could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g., endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from feeding areas impacted by the spill due to the presence of oil and increased vessel activity could result in impacts of higher magnitude.

Temporary and/or permanent injury and non-lethal effects could occur, but mortality is not likely. If an oil spill were to cause extensive mortality within a high latitude amphipod (bowhead whale prey) population with low fecundity and long generation times, a marked decrease in secondary production could ensue in some areas (Highsmith and Coyle 1992), which could impact bowhead whales. Exposure to contaminated prey multiple times over the long lifetime of these whales could increase contamination of whale tissues through accumulation of toxins within those tissues. Because the statistical probability of large oil spills occurring is very small, any consumption of contaminated prey is unlikely to accumulate to levels that would harm individual whales.

Based on the localized nature of small oil spills, the relatively rapid weathering expected for <1,000 bbl of oil, the small number of anticipated spills for the proposed action, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of Hilcorp activity causing a small oil spill and exposing bowhead whales is sufficiently small 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 whales and would consider exposure insignificant.

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 potential biological removal (PBR). However, due to the low likelihood of a large oil spill, and even lower predicted likelihood of a VLOS, the risk of significant exposures of whales to such discharges of oil is extremely low.

Ringed and Bearded Seals

Ringed and bearded seals can occur in the action area year-round; therefore, they have the potential to be exposed to an oil spill if there is an overlap in the presence and spatial extent of an oil spill. However, the presence of bearded seals during the winter is minimal (Section 4.1.5). In the event of an oil spill, ringed and bearded seals could be adversely affected to varying degrees depending on habitat use, densities, season, and various spill characteristics.

Based on the localized nature of small spills and the relatively rapid attenuation and dispersion of less than 1,000 bbl of refined oil, the small number of predicted spills, the safeguards in place to avoid and minimize oil spills, and the small number of past Arctic spills, the likelihood of a small spill affecting ringed and bearded seals is low. A small oil spill would be localized and would not permanently affect fish and invertebrate populations that are ringed and bearded seal prey. The amount of fish and other prey lost in such a spill likely would be undetectable compared to what is broadly available throughout the range of the two seal species, which both forage over large areas of the Beaufort Sea and do not rely on local prey abundance.

Depending on the size of the spill, oil may concentrate in ice leads and in breathing holes, and may be held closer to the surface against ice edges where seals tend to travel (Engelhardt 1987). Floating sea ice also reduces wave action and surface exchange thus delaying the weathering and dispersion of oil and increasing the level and duration of exposure to seals. Low temperatures make oil more viscous and increase the hazards associated with fouling of animals. It also reduces evaporation of volatile hydrocarbons, lessening the acute levels of toxins in the air but lengthening the period of exposure (Engelhardt 1987).

Surface contact with petroleum hydrocarbons, particularly the low-molecular-weight fractions, to seals can cause temporary damage of the mucous membranes and eyes (Davis et al. 1960) or epidermis (Walsh et al. 1974, Hansen 1985, Geraci and St. Aubin 1990b). Contact with crude oil can damage eyes (Davis et al. 1960), resulting in corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes (Geraci and Smith 1976a, Geraci and Smith 1976b). Crude oil immersion studies resulted in 100 percent mortality in captive ringed seals (Geraci and Smith 1976b). Unlike the animals in the immersion study, seals in the wild would have ice as a resting/escape platform or, during the open water period, water depth and distance for escape routes from an oil spill, which they might detect and avoid (Geraci and St. Aubin 1990a). Researchers have suggested that pups of ice-associated seals may be particularly vulnerable to fouling of their dense lanugo coat (Geraci and St. Aubin 1990a, Jenssen 1996). Though bearded seal pups exhibit some prenatal molting, they are generally not fully molted at birth, and thus would be particularly prone to physical impacts of contacting oil. Adults, juveniles, and weaned young of the year rely on blubber for insulation, so effects on their thermoregulation are expected to be minimal since they are not as reliant on their coats for insulation.

Other acute effects of oil exposure which have been shown to reduce seal health and possibly survival include skin irritation, disorientation, lethargy, conjunctivitis, corneal ulcers, and liver lesions. Direct ingestion of oil, ingestion of contaminated prey, or inhalation of hydrocarbon vapors can cause serious health effects including death (Geraci and Smith 1976a, Geraci and St. Aubin 1990a). Based on the documented exposures of ringed seals and other phocid species to oil, however, significant effects on health and survival would be expected for seals immersed or coated in oil during the days and weeks following a spill (Geraci and St. Aubin 1990a).

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 seals could increase contamination of seal tissues through accumulation of toxins within those tissues. A VLOS could affect large numbers of seals, 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 seals. A low probability, high impact circumstance where large numbers of ringed and bearded seals experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality of a substantial number of seals.

Based on the localized nature of small oil spills, the relatively rapid weathering expected for

<1,000 bbl of oil, the small number of spills anticipated, and the safe guards in place to avoid and minimize oil spills, we conclude that the probability of a Hilcorp activity causing a small oil spill and exposing ringed and bearded seals is sufficiently small 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 seals and would consider exposure insignificant.

Large or very large spills are not reasonably likely to occur. A low probability, high impact circumstance where large numbers of ringed and bearded seals experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality of a substantial number of seals. However, due to the low likelihood of large oil spills, and even lower predicted likelihood of a VLOS, the risk of significant exposures of seals to such discharges of oil is extremely low.

6.1.5.2 Oil Spill Drills

Spill response training and drills will occur during the open water and winter months throughout the project life (Section 2.1.1.6). BSEE will also conduct oil spill drills in the form of infrequent, short duration government initiated drills. BSEE endeavors to coordinate with and include other Federal, State, and local agencies where appropriate to reduce impacts on government, industry, and the environment. Hilcorp is required to carry out the training, equipment testing, and periodic oil spill response drills described in their OSRP.

During the ice-covered periods, exercises will be conducted to practice tactics involving detection, containment, and recovery of oil on and under the ice. These exercises will mostly be on bottom-fast ice and will require snow machines and all-terrain vehicles. The spill equipment deployment exercise includes using various types of equipment to cut ice slots or drill holes through the floating sea ice. Typically, the snow is cleared from the ice surface with a skidsteer loader and snow blower that allows access to the ice. Two portable generators are used to power light plants at the exercise site. The locations and frequency for future spill drills or exercises will vary depending on sea ice conditions and training needs.

ACS also conducts spill response training activities during the open-water season from late July through early October. Vessels used as part of this training typically include Zodiacs, Kiwi Noreens, and Bay-class boats that range in length from 3.7 to 13.7 m (12 to 45 ft). Future exercises could include other vessels and equipment.

ARKTOS amphibious emergency escape vehicles may be stationed at Liberty as they are at Northstar Island. Each ARKTOS is capable of carrying 52 people. Training exercises with the ARKTOS are conducted monthly during the ice-covered period. ARKTOS training exercises are not conducted during the summer. Equipment and techniques used during oil spill response exercises are continually updated, and some variations relative to the activities described here are to be expected.

Bowhead Whales, Ringed Seals, and Bearded Seals

The range of effects to whales and pinnipeds associated with oil spill drill activities are anticipated to be similar to those discussed above for vessel/aircraft noise, and vessel strike (see Sections 6.2.1.8-6.2.1.9).

During spill drills, whales and pinnipeds could be exposed to harassment levels of noise from vessels and increased risk of ship strike. Whales and pinnipeds are vulnerable to entanglement with underwater lines and could be injured or killed if they become badly entangled in underwater response equipment (e.g., boom lines or anchoring systems), particularly if the equipment is left unattended. However, exposures would be reduced by implementing mitigation measures identified in the OSRPs and through consultation with NMFS (e.g., having observers on vessels, minimizing boom installation, and minimizing in-water time).

6.1.5.3 Oil Spill Response and Cleanup Activities

Oil spill response activities are not a component of the proposed action and have been previously consulted on by NMFS as part of the *Alaska Federal/State Preparedness Plan for Response to Oil & Hazardous Substance Discharges/Releases (Unified Plan)* consultation (AKR 2014-9361).

6.1.6 Trash and Debris

The Liberty 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 can pose significant risks to marine mammals, and is anticipated to be more common and widespread than accidental or illegal oil discharges.

Hilcorp will to comply with Federal regulations and BOEM's trash and debris guidance, so the amount of trash and debris occurring within the action area is expected to be minimal resulting in an insignificant effect on all ESA-listed species.

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.

We searched for information on non-Federal actions reasonably certain to occur in the action area. We did not find any information regarding non-Federal actions other than what has already been described in the Environmental Baseline (see Section 5 of this opinion). We expect fisheries, subsistence harvest, noise, oil and gas activities, pollutants and discharges, scientific research, and ship strike will continue into the future. We expect moratoria on commercial whaling and bans on commercial sealing will remain in place, aiding in the recovery of ESA-listed whales and pinnipeds.

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 *versus* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 5.0).

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 both 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 appreciable reductions in the value of designated critical habitat for the conservation of the listed 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 (Stearns 1977, 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.

We assume that existing regulations or similar regulatory requirements will apply over the life of the Liberty project. Regulatory changes may require reinitiation of consultation per 50 CFR 402.16. In addition, we assume that all required mitigation measures will be implemented. If required mitigation measures are not incorporated into the proposed action by Hilcorp, the action agencies may need to reinitiate consultation per 50 CFR 402.16. Finally, we did not consider optional mitigation measures that may be included by BOEM or other cooperating agencies as part of their project authorization processes.

Bowhead Risk Analysis

Based on the results of the exposure analysis (see Section 6.2), we expect bowhead whales may be exposed to underwater noise from sheet pile driving/removal, pipe driving, slope shaping, drilling activities, and spill response training that may result in Level B harassment takes. Impact sheet pile and impact pipe driving and removal may result in Level A harassment takes. Exposure to vessel noise, aircraft noise, noise from geohazard surveys, habitat alteration, and small oil spills may occur but are considered insignificant and would not rise to the level of take. Stressors associated with on-ice activities (ice road, ice trail, and ice pad construction, maintenance, operation, and decommissioning), and gravel placement to construct the island are not anticipated to overlap in time and space with bowhead whales and would have no effect. Finally, exposure to vessel strike, authorized discharge, and marine debris is extremely unlikely to occur and therefore considered discountable, and because large and very large oil spills are considered extremely unlikely to occur, we consider them low probability, high-impact events.

Our consideration of probable exposures and responses of bowhead whales to oil and gas development, production, and decommissioning 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 bowhead whales in terms of both survival and recovery of the species.

Mitigation measures required for pile and pipe driving/removal and aircraft and vessel operations would further reduce the impacts to bowhead whales (BOEM 2017a). 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. However, due to the low likelihood of 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.

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). Whales have an ability to store substantial amounts of energy, which allows them to survive for months on stored energy during migration and while in wintering areas, and their feeding patterns allow them to acquire energy at high rates. The individual and cumulative energy costs of the behavioral responses we have discussed in this opinion are not likely to reduce the overall energy budgets of listed whales. As a result, the whales' probable responses to close approaches by vessels (i.e., reduce the amount of time they spend at the ocean's surface, increase their swimming speed, change their swimming direction to avoid vessel or pile driving operations, change their respiration rates, increase dive times, reduce feeding behavior, or alter vocalizations and social interactions) and their probable exposure to noise sources are not likely to reduce the fitness or current or expected future reproductive success of listed whales or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent.

Based on the annual activity scenarios provided by Hilcorp and BOEM/BSEE (BOEM 2017a, Hilcorp 2018a) (see Table 22), NMFS estimated that maximum instances of exposure to bowhead whales from Level B noise harassment at received sound levels ≥120 dB re 1 μPa rms for continuous noise sources, or ≥160 dB e 1 μPa rms for impulsive noise sources depending on the ensonified areas (see Table 22) is 120 over the life of the project. (see *Response Analysis*) over the life of the project. In addition, up to four bowhead whales may be exposed to Level A harassment during impact pile installation/removal activities over the life of the project.

These estimates represent the total number of takes of bowhead that could potentially occur, not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of the proposed action. These exposure estimates are likely to be overestimates because they assume a uniform distribution of bowheads, do not account for avoidance or the effectiveness of mitigation measures in reducing take, and assume all planned wells will be drilled.

Exposure to vessel noise from transit, aircraft noise (fixed-wing aircraft, helicopters, and UAS), noise from geohazard surveys, habitat alteration, and small oil spill discharge may occur as part of the proposed action, but are considered insignificant and would not rise to the level of take. The occurrence of vessel strikes of bowhead whales are considered extremely unlikely due to the implementation of mitigation measures and low number of vessels associated with the action. Exposure to harmful marine debris is extremely unlikely. Large and very large oil spills are considered low-probability, high-impact events (see Sections 6.2.1 through 6.2.6).

Based on the localized nature of small oil spills, the relatively rapid weathering expected for <1,000 bbl of oil, the small number of spills anticipated with the proposed action, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of a Hilcorp activity causing a small oil spill and exposing bowhead whales in association with the Liberty project is sufficiently small as to be considered improbable. If exposure were to occur, due to the ephemeral nature of small, oil spills, NMFS does not expect detectable responses from whales, and we would consider the effects of the proposed action to be minor.

While individual bowhead whales may be exposed multiple times to pipe and pile driving/removal noise over the course the project, the short duration of exposure and the implementation of mitigation measures to reduce exposure to high levels of sound reduce the likelihood that exposure to pile driving/removal sound would cause a behavioral response that may affect vital functions of whales.

For drilling operations, considering that this will be a continuous source of underwater noise, it is not anticipated that bowhead whales would enter into an area where they would suffer from acoustic harassment unless they were compelled to do so (such as to take advantage of prey aggregations). We anticipate most bowhead whales will deflect around the ensonified area.

Although the oil and gas 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. Waters that are acoustically impacted by drilling and production sounds represent a diminishingly small portion of bowhead feeding habitat, and bowheads typically use this area (primarily outside the barrier islands) as a migration corridor, with individual whales spending only a small amount of time within these waters.

The strongest evidence supporting the conclusion that oil and gas activities will likely have minimal impact on bowhead whales is the estimated growth rate of the whale populations in the Arctic and sub-Arctic. The Western Arctic stock of bowhead whales has been increasing at approximately 3.2-3.7 percent per year (George et al. 2004, Schweder and Sadykova. 2009, Givens et al. 2013), while simultaneously exposed to sustained subsistence harvest and oil and gas exploration and development activities in the Beaufort and Chukchi Seas. The maximum theoretical net productivity rate is 4% for the Western Arctic stock of bowhead (Muto et al. 2017). The time series of abundance estimates indicates an approximate 50% increase in total abundance of bowhead whales during the last ten years, and a doubling in abundance since the early 1990s (LGL Alaska Research Associates Inc. et al. 2014). Despite exposure to oil and gas exploration and development activities in the Beaufort and Chukchi Seas since the late 1960s (BOEM 2017a), and continued subsistence harvest, this increase in the number of listed whales suggests that the stress regime these whales are exposed to in or near the action area has not prevented them from increasing their numbers in the Beaufort and Chukchi Seas.

Given the life history of bowhead whales and gestational constraints on minimum calving intervals (e.g., (Reese et al. 2001), and assuming that adult survival rates based on aerial photo-ID data (Zeh et al. 2002, Schweder et al. 2010) and age-at-maturity have remained stable, the trend in abundance implies that the population has been experiencing relatively high annual calf and juvenile survival rates. This is consistent with documented observations of native whalers around St. Lawrence Island, who have reported not only catching more pregnant females but also seeing more young whales than during earlier decades (Noongwook et al. 2007). While the sample size was small, the pregnancy rate from the 2012 Alaskan harvest data indicated that 2013 calf production was higher than average (George et al. 2004, George et al. 2011, Suydam et al. 2013).

As discussed in the *Environmental Baseline* section of this opinion, bowhead whales have been exposed to active seismic, construction, and drilling activities in the Arctic, including vessel traffic, aircraft traffic, and seismic and drilling noise, for generations. Although we do not know if more bowhead whales might have used the action area or if the reproductive success of bowhead whales in the Arctic would be higher absent their exposure to these activities, the rate at which these whales occur in the Arctic suggests that bowhead whale numbers have increased substantially in these important migration and feeding areas despite exposure to oil and gas activities. We do not believe the proposed activities are likely to affect the rate at which bowhead whales in the action area are increasing.

During the proposed action, a low probability, high-impact event involving an unauthorized large oil spill where large numbers of whales might experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil could result in injury and mortality that exceeds PBR (161 bowhead). BOEM estimates that there is a 99.33% chance of no large spills occurring in association with the proposed action. No VLOS is expected (the estimated probability is 2.46 x 10^{-5} spills per well; see BOEM 2017c) based on historical occurrence, and differences in Arctic drilling conditions that make a catastrophic discharge even less likely than the DWH event. Based on these factors, the risk of significant long term exposures of bowhead whales to accidental discharges of oil from a large or very large oil spill is low.

A change in either bowhead whale calf production or survival rates (or age-at-sexual maturation) of young whales in the future could be indicative of a population level response to anthropogenic stressors, or alternatively, a signal of the seemingly inevitable event that this population approaches the carrying capacity of its environment (Eberhardt 1977). Since the late 1970s and the initiation of surveys for abundance, however, the estimates of population size do not indicate that either anthropogenic (e.g., offshore oil and gas activities, subsistence whaling catch quotas, etc.) or natural factors (e.g., prey availability) have resulted in any negative influence on the bowhead whale trend in abundance (LGL Alaska Research Associates Inc. et al. 2014).

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 bowhead whale. As a result, the development, production, and decommissioning activities authorized for the Hilcorp Liberty project from December 2020 through November 2045 are not likely to appreciably reduce this species' likelihood of surviving or recovering in the wild.

Pinniped Risk Analysis

Based on the results of the exposure analysis (see Section 6.2), we expect ringed and bearded seals may be exposed to underwater noise from island construction, sheet pile driving/removal, pipe driving, slope shaping, drilling activities, and spill response training that may result in Level B harassment takes. Impact sheet pile and pipe driving and removal may result in Level A harassment takes. Exposure to vessel noise, aircraft noise, noise from geohazard surveys, habitat alteration, authorized discharge, and small oil spills may occur but are considered insignificant and would not rise to the level of take. Stressors associated with on-ice activities (ice road, ice trail, and ice pad construction, maintenance, operation, and decommissioning) may result in Level B harassment through noise for both ringed and bearded seals; Level B harassment through physical presence for ringed seals; and mortality for ringed seals. Finally, exposure to vessel strike and marine debris is extremely unlikely to occur and therefore considered discountable, and because large and very large oil spills are considered extremely unlikely to occur, we consider them low probability, high-impact events.

Mitigation measures required for ice roads/trails/pads, pile and pipe driving/removal, and aircraft and vessel operations would further reduce the impacts to ringed and bearded seals (BOEM 2017a). The effects of a large oil spill would be significantly greater than small spills. A low probability, high-impact circumstance where large numbers of ice seals experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality of a substantial number of ice seals. However, due to the low likelihood of large oil spills, and even lower predicated likelihood of a VLOS, the risk of significant long-term exposures of ice seals to accidental discharges of oil is extremely low.

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). Fall and early winter periods, prior to the occupation of breeding sites, are important in allowing female ringed seals to accumulate enough fat stores to support estrus and lactation (Kelly et al. 2010). This fall and early winter time period overlaps with ice road construction, island construction, drilling operations, and deconstruction activities. However, the individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of ringed and bearded seals. As a result, the ringed and bearded seal's probable responses (i.e., tolerance, avoidance, short-term masking, and short-term vigilance behavior) to close approaches by vessels or vehicles and their probable exposure to noise or human disturbance are not likely to reduce the fitness or current or expected future reproductive success or reduce the rates at which they grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent. For physical disturbance, if an active ringed seal lair is not detected and is incidentally impacted by heavy equipment, the adult female could likely escape into the water but the pup could be killed by crushing or premature exposure to the water or frigid air. Timing restrictions would likely avoid adverse effects to newborn ringed seal pups, particularly when nursing and molting. However, if activities associated with ice roads, trails, or pads occur after March 1st a few mortalities or physical harassments may occur. While individuals may be impacted, these impacts are not likely to reduce the abundance, reproductive rates, or growth rates of the populations those individuals represent.

Based on the annual activity scenarios provided by Hilcorp and BOEM/BSEE (BOEM 2017a) (Hilcorp 2018a) (see Table 22), NMFS estimated that maximum instances of exposure to ringed seals (542), and bearded seals (96) would result from noise from vibratory pile and pipe driving/removal during the spring and summer, at received levels sufficiently high (or distances sufficiently close) that might result in behavioral harassment (see *Response Analysis*) over the life of the project.

In total, the proposed action is anticipated to result in 831 instances of exposure to ringed seals, and 130 instances of exposure to bearded seals due to Level B noise harassment at received sound levels ≥120 dB re 1 μPa rms for continuous noise sources, or ≥160 dB e 1 μPa rms for impulsive noise sources depending on the ensonified areas (see Table 22) and physical presence. Impact pipe and pile driving/removal may result in up to 10 instances of Level A exposure to ringed seals and 4 instances of Level A exposure to bearded seals over the life of the project. Ice road construction and maintenance may result in up to 10 ringed seal mortalities over the life of the project.

These estimates represent the total number of takes that could potentially occur, not necessarily the number of individual seals taken, as a single individual may be "taken" multiple times over the course of the proposed action. These exposure estimates are likely to be overestimates because they assume a uniform distribution of seals, do not account for avoidance or the effectiveness of mitigation measures in reducing take, and assume all of the planned wells will be drilled.

Exposure to vessel noise, aircraft noise (fixed-wing aircraft, helicopters, and UAS), noise from geohazard surveys, habitat alteration, and small oil spill discharge may occur as part of the proposed action, but are considered insignificant and would not rise to the level of take. The occurrence of vessel strikes are considered extremely unlikely due to the agility of seals in the water, implementation of mitigation measures, and low number of vessels associated with the action. Exposure to harmful marine debris is extremely unlikely. Large and very large oil spills are considered low probability, high-impact events (see Sections 6.2.1 through 6.2.6).

Based on the localized nature of small oil spills, the relatively rapid weathering expected for <1,000 bbl of oil, the small number of spills anticipated with the proposed action, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of a Hilcorp activity causing a small oil spill and exposing ringed or bearded seals in association with the Liberty project sufficiently small as to be considered improbable. If exposure were to occur, due to the ephemeral nature of small, oil spills, NMFS does not expect detectable responses from pinnipeds, and we would consider the effects of the proposed action to be minor.

While individual seals may be exposed multiple times to pipe and pile driving/removal noise over the course the project, the short duration of exposure, and the implementation of mitigation measures to reduce exposure to high levels of sound, reduce the likelihood that exposure to pipe and pile driving/removal sound would cause a behavioral response that may affect vital functions.

For drilling operations, considering that this will be a continuous source of underwater noise, it is not anticipated that marine mammals would enter into an area where they would suffer from acoustic harassment unless they were compelled to do so (such as to take advantage of prey aggregations which is unlikely since they are broadly distributed). We anticipate most ice seals will deflect around the ensonified area.

Although the oil and gas development and production activities are likely to cause some individual ringed and bearded seals 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 seals in ways or to a degree that would reduce their fitness because even if the seals are actively foraging in waters around the construction or drilling operations they can avoid intense exposure by lifting their heads above water, or hauling out.

Ringed and bearded seals that avoid these sound fields or exhibit vigilance are not likely to experience significant disruptions of their normal behavior patterns because the vessels are transiting and the ensonified area is temporary, and ringed seals seem rather tolerant of low frequency noise. Drilling operations at Northstar facility during the open-water season resulted in brief, minor localized effects on ringed seals with no consequences to ringed seal populations (Richardson and Williams 2004). Adult ringed seals seem to tolerate drilling activities. Brewer et al. (1993) noted ringed seals were the most common marine mammal sighted and did not seem to be disturbed by drilling operations at the Kuvlum #1 project in the Beaufort Sea. Southall et al. (2007) reviewed literature describing responses of pinnipeds to continuous sound and reported that the limited data suggest exposures between ~90 and 140 dB re 1 μPa generally do not appear to induce strong behavioral responses in pinnipeds exposed to continuous sounds in water.

During the proposed action, a low probability, high-impact circumstance where large numbers of seals experience prolonged exposure to toxic fumes, and/or ingest large amounts of oil, could result in injury and mortality of a substantial number of individual seals. However, due to the low likelihood of large oil spills, and even lower predicated likelihood of a VLOS, the risk of significant long-term exposures of seals to accidental discharges of oil is low.

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 seals would not be likely to reduce the viability of the populations those individual seals 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 ringed and bearded seal. As a result, the development, production, and decommissioning activities authorized for the Hilcorp Liberty project from December 2020 through November 2045 are not likely to appreciably reduce the ringed seals' or bearded seals' likelihood of surviving or recovering in the wild.

9 CONCLUSION

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS's biological opinion that the proposed action is **not likely to jeopardize the continued existence of the following species:**

- **Bowhead whales**
- **Arctic ringed seals**
- **Beringia DPS bearded seals**

No critical habitat has been designated for these species, therefore, none will be affected.

In addition, the proposed action is **not likely to adversely affect the follow species or critical habitats:**

- Blue whales
- North Pacific right whales
- Sperm whales
- Fin whales
- Western North Pacific DPS humpback whales
- Mexico DPS humpback whales
- Western DPS Steller sea lions
- North Pacific right whale critical habitat
- 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. "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 recent 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 harassment associated with noise exposure, and Level B harassment and mortality associated with physical presence during ice road construction and maintenance takes 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 the prohibition on take in Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here (Section 9 of the ESA, however, does not apply to ringed or bearded seals)**. Absent such authorization, this incidental take statement is inoperative. Prior to the occurrence of any take, BOEM's lessee (Hilcorp) therefore will need to obtain authorization under the MMPA for incidental take of small numbers of marine mammals from NMFS's Permits Division. The issuance of a Letter of Authorization (LOA) constitutes an agency action for the purposes of section 7(a)(2) of the ESA.

The terms and conditions described below are nondiscretionary. The action agencies (BOEM, BSEE, EPA, USACE, 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, the action agencies 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 the action agencies (1) fail to require Hilcorp 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.

The ESA does not prohibit the taking of threatened species unless special regulations have been promulgated, pursuant to ESA Section 4(d), to promote the conservation of the species. ESA Section 4(d) rules have not been promulgated for Arctic ringed seals or Beringia DPS bearded seals; therefore, ESA section 9 take prohibitions do not apply to these two species. This ITS includes numeric limits on taking of these species because specific amounts of take were analyzed in our jeopardy analysis. These numeric limits provide guidance to the action agency on its requirement to re-initiate consultation if the amount of take estimated in the jeopardy analysis of this biological opinion is exceeded. This ITS includes reasonable and prudent measures and terms and conditions designed to minimize and monitor take of these threatened species.

Amount or Extent of Take

Section 7 regulations require NMFS to estimate the number of individuals that may be taken by a proposed action 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); see also 80 FR 26832 (May 11, 2015)).

NMFS anticipates the proposed Liberty Project is likely to result in the incidental take of ESA-listed species by Level A harassment (noise), Level B harassment (noise and physical presence), and mortality for a small number of ringed seals. As discussed in Section 6.2.1 of this opinion, the proposed action is expected to take the following number of ESA-listed individuals described in Table 28. For a breakdown of take by stressor see Table 21 and Table 22 and Section 6.2.1.4.

Table 27. **Summary of incidental take of bowhead whales, ringed seals, and bearded seals.**

Species	**Type of Take**	**Year**								**Total Take**	
		1	**2**	**3**	**4**	**5**	**6-23**	**24**	**25**	**Years 1-5**	**Life of Project**
Bowhead Whale	Level B Harassment	6	5	5	5	5	90 (5 *per year)*	0	4	26	120
	Level A Harassment	2	0	0	0	0	0	0	2	2	4
	Mortality	0	0	0	0	0	0	0	0	0	0
Bearded Seal	Level B Harassment Noise and Physical Presence	58	1	1	1	1	18 *(1 per year)*	1	49	62	130
	Level A Harassment	2	0	0	0	0	0	0	2	2	4
	Mortality	0	0	0	0	0	0	0	0	0	0
Ringed Seal	Level B Harassment Noise and Physical Presence	336	9	23	23	20	108 *(6 per year)*	16	296	411	831
	Level A Harassment	5	0	0	0	0	0	0	5	5	10
	Mortality	2					8 *(2 per 5 years)*			2	10
Note: To be conservative, take estimates have been rounded up per year.											

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 species or destruction or adverse modification of critical habitat.

The majority of authorized takes from the proposed action are associated with behavioral harassment from acoustic noise, and a small number of ringed seals are anticipated to be taken by serious injury, mortality, or harassment from on-ice activities (Sections 6.2.1.4-6.2.1.5). Although the biological significance of behavioral responses remains unknown, this consultation has assumed that exposure to major noise sources 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 serious injury or mortality of a small number of ringed seals is a very small fraction of the overall population.

Reasonable and Prudent Measures (RPMs)

"Reasonable and prudent measures" are nondiscretionary measures necessary or appropriate to minimize the amount or extent of incidental take (50 CFR 402.02).

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 bowhead whales, ringed seals, and bearded seals 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 may result in the modification, suspension, or revocation of the ITS.
3. The take of ESA-listed marine mammals by serious injury or mortality, whether authorized or unauthorized, will be immediately reported to NMFS AKR.
4. BOEM/BSEE must implement a monitoring program that allows NMFS AKR to evaluate the take estimates contained in this biological opinion and that underlie this incidental take statement.
5. BOEM/BSEE must submit reports to NMFS AKR that evaluate its mitigation measures and the results of its annual monitoring program.

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, 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. 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, BOEM or Hilcorp must undertake the following:

A. The action agencies must require Hilcorp to apply for and receive the appropriate authorizations under section 101(a)(5) of the MMPA, for activities that involve the take of threatened or endangered marine mammals.

B. 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.

To carry out RPM #2, 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[15] 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 and/or by email to jon.kurland@noaa.gov, alicia.bishop@noaa.gov, the Marine Mammal Stranding Hotline at 877-925-7773, and NMFS Permitting Division (Jaclyn Daly at 301-427-8438) for any MMPA authorization issues. 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) if applicable, 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. BOEM must work with NMFS and Hilcorp to determine what is necessary to minimize the likelihood of further prohibited take and ensure ESA compliance. Hilcorp 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 and/or by email to jon.kurland@noaa.gov, alicia.bishop@noaa.gov, the Marine Mammal Stranding Hotline at 877-925-7773, and NMFS Permitting Division Jaclyn Daly 301-427-8438 for any MMPA authorization issues.

To carry out RPM #3, BOEM or Hilcorp must undertake the following:

A. In the event that the proposed action causes take (authorized or unauthorized) of an ESA-listed marine mammal that results in an observed serious injury or mortality, that incident

[15] Serious injury means "any injury that will likely result in mortality" (50 CFR 216.3).

must be reported within 24 hours to NMFS AKR, Protected Resources Division at 907-586-7638 and/or by email to jon.kurland@noaa.gov, alicia.bishop@noaa.gov, the Marine Mammal Stranding Hotline at 877-925-7773, and NMFS Permitting Division Jaclyn Daly 301-427-8438 for any MMPA authorization issues. 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) if applicable, 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.

To carry out RPM #4, BOEM or Hilcorp must undertake the following:

A. BOEM or Hilcorp shall require all protected species observers to complete a protected species observer training course. All protected species observer training programs must:
    a. Furnish BOEM a course information packet that includes the name and qualifications (i.e., experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material;
    b. Furnish each trainee with a document stating successful completion of the course; and
    c. Provide BOEM with names, affiliations, and course completion dates for trainees. The training course must include the following topics:
        i. Brief overview of the MMPA and the ESA as they relate to the Liberty Project.
        ii. Brief overview of project activities to be monitored.
        iii. Overview of mitigation measures and the protected species observer program.
        iv. Discussion of the role and responsibilities of the protected species observer, including:
            1. Legal requirements (why you are here and what you do);
            2. Professional behavior (code of conduct);
            3. Integrity;
            4. Authority of protected species observer to call for shutdown of operations;
            5. Assigned duties;
            6. What can be asked of the observer verse what cannot be asked of the observer;
            7. Reporting of violations and coercion;
            8. Identification of marine mammals;

9. Cues and search methods for locating marine mammals; and,
10. Distance determination techniques and training.

v. Data collection and reporting requirements.

To carry out RPM #5, BOEM or Hilcorp must undertake the following:

A. In the event that Hilcorp reaches, or appears likely to exceed, the limit on annual take authorized for any specific activity as described in this ITS, BOEM/BSEE 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, bonnie.easley-appleyard@noaa.gov, and NMFS Permitting Division at 301-427-8438, and email Jaclyn.daly@noaa.gov. NMFS AKR will work with BOEM and Hilcorp 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 or Hilcorp must prepare an annual report summarizing ESA-listed marine mammal sightings and annual takes of listed marine mammals. The annual report will be submitted by May 1 of the year following the calendar year during which activities occurred. 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 final report prior to NMFS acceptance of the final 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 90 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).

1. BOEM/BSEE should implement the following measures to help standardize the Protected Species Observer Program. These measures were co-developed with BOEM, BSEE and NMFS in the National standards for a protected species observer and data management program (Baker et al. 2013):
   - Develop a reimbursable agreement with NMFS to develop, implement, and manage the PSO training and data program;

- Consider assessing permit fees to financially support the PSO program needed for industry activities;
- Implement standardization for data collection methods, electronic forms, and software used in collaboration with NMFS and non-federal stakeholders;
- Develop permits or agreements detailing expectations and data collection and reporting of third-party PSO provider companies, including performance standards, conflicts of interest, and standards of conduct;
- Implement quality assurance standards and manage PSO data for annual data analysis;
- Establish a process to advertise for and approve PSO procedures;
- Hold a stakeholder workshop to discuss new PSO procedures;
- Develop a mechanism, procedure, or regulation to ensure that selected PSO providers are being compensated prior to deployment of approved observers; and
- Develop a debriefing and evaluation system for observers.

2. Under the BOEM Environmental Studies Program, consider studies specifically designed to assess abundance, population trends, habitat use during open-water and in-ice seasons, and productivity of ringed and bearded seal populations that may be affected by oil and gas development;
3. BOEM and Hilcorp in coordination with NMFS should develop recommended best management practices (BMPs) regarding the use of UAS for marine mammal monitoring in the Arctic. BMPs should address:
    a. Altitude for effective and feasible marine mammal monitoring while limiting impacts to cetaceans and pinnipeds;
    b. Analyzing behavioral impacts of UAS operation on both cetaceans and pinnipeds and developing measures to mitigate impacts, if necessary;
    c. Data sharing protocols;
    d. Pilot training for UAS operation around marine mammals, including applicable knowledge and training for operating UAS (1) to monitor marine mammals and (2) in Arctic conditions.
4. As part of the permitting process for Liberty, NMFS recommends that BOEM/BSEE require Hilcorp to provide information describing its preparedness and ability for marine mammal response in the event of an oil spill, as outlined in Appendix G of the Alaska Unified Response Plan and the specific marine mammal response guidelines (e.g., NMFS's Arctic Marine Mammal Disaster Response Guidelines, and Pinniped and Cetacean Oil Spill Response Guidelines) including wildlife response procedures, contracts with wildlife response/rehabilitation organizations, equipment caches, and training;
5. BOEM/BSEE should work with NMFS and other species experts to develop strategies that could be implemented to prevent oil contacting listed species in the event of a large marine spill;

6. BOEM/BSEE should work with NMFS and other relevant stakeholders (the Marine Mammal Commission, International Whaling Commission, and the marine mammal research community) to develop a method for assessing the cumulative impacts of anthropogenic noise on marine mammals. This analysis includes the cumulative impacts on the distribution, abundance, and the physiological, behavioral and social ecology of these species.

In order to keep NMFS's Protected Resources Division informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, BOEM should notify NMFS of any conservation recommendations they implement in their final action.

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.

Utility

This document records the results of an interagency consultation. The information presented in this document is useful to NMFS, BOEM, BSEE, USACE, EPA, 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.

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.

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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