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

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

Port of Alaska North Extension Stabilization Step 1, Anchorage, Alaska

NMFS Consultation Number: AKRO-2022-03630

Action Agencies: National Marine Fisheries Service (NMFS), Office of Protected Resources, Permits and Conservation Division; U.S. Army Corps of Engineers (USACE)

Affected Species and Determinations:

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

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By: ______________________
Jonathan M. Kurland
Regional Administrator

Date: December 15, 2023

Accessibility of this Document

Every effort has been made to make this document accessible to individuals of all abilities and compliant with Section 508 of the Rehabilitation Act. The complexity of this document may make access difficult for some. If you encounter information that you cannot access or use, please email us at Alaska.webmaster@noaa.gov or call us at 907-586-7228 so that we may assist you.

TABLE OF CONTENTS

1. INTRODUCTION 11
1.1 Background 12
1.2 Consultation History 13
2. DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA 15
2.1 Proposed Action 15
2.1.1 Proposed Activities 15
2.1.1.1 Excavation 18
2.1.1.2 Dredging and Disposal 18
2.1.1.3 Pile Installation and Removal 19
2.1.1.3.1 Alternative Methods of Sheet Pile Removal 21
2.1.1.4 Shoreline Stabilization 22
2.1.2 Mitigation Measures 23
2.2 Action Area 31
3. APPROACH TO THE ASSESSMENT 33
4. RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT 35
4.1 Species and Critical Habitat Not Likely to be Adversely Affected by the Action 35
4.2 Climate Change 40
4.3 Status of Listed Species and Critical Habitat Likely to be Adversely Affected by the Action 45
4.3.1 Cook Inlet DPS Beluga Whale 46
4.3.1.1 Status and Population Structure 46
4.3.1.2 Distribution 48
4.3.1.2.1 Presence in the Action Area 49
4.3.1.3 Feeding and Prey Selection 51
4.3.1.4 Reproduction 51
4.3.1.5 Vocalization, Hearing, and Other Sensory Capabilities 51
4.3.1.6 Threats 52
4.3.2 Mexico and Western North Pacific DPS Humpback Whales 54
4.3.2.1 Population Structure and Status 54
4.3.2.2 Distribution 54
4.3.2.2.1 Presence in Cook Inlet 55
4.3.2.3 Feeding and Prey Selection 55
4.3.2.4 Reproduction 55
4.3.2.5 Vocalization, Hearing, and Other Sensory Capabilities 56
4.3.2.6 Threats 56
4.3.2.6.1 Natural Threats 56
4.3.2.6.2 Anthropogenic Threats 56
4.3.3 Steller Sea Lion 57
4.3.3.1 Population Structure and Status 57

4.3.3.2 Distribution 58
4.3.3.2.1 Presence in Cook Inlet 59
4.3.3.3 Feeding, Diving, Hauling out, and Social Behavior 60
4.3.3.4 Reproduction 61
4.3.3.5 Vocalization, Hearing, and Other Sensory Capabilities 61
4.3.3.6 Threats 61
4.3.3.6.1 Natural Threats 61
4.3.3.6.2 Anthropogenic Threats 62
5. ENVIRONMENTAL BASELINE 62
5.1 Recent Biological Opinions in the Action Area 63
5.2 Coastal Development 63
5.2.1 Road Construction 64
5.2.2 Port Facilities 65
5.2.2.1 Port of Alaska 65
5.2.2.2 Port MacKenzie 66
5.2.2.3 Other Ports 67
5.3 Oil and Gas Development 67
5.3.1 Kenai Liquefied Natural Gas Plant 68
5.4 Underwater Installations 72
5.4.1 Hilcorp Cook Inlet Pipeline Cross Inlet Extension 72
5.4.2 Alaska LNG Project 72
5.4.3 Tidal Energy Project 73
5.5 Natural and Anthropogenic Sound 73
5.5.1 Seismic Surveys in Cook Inlet 73
5.5.1.1 Apache Seismic Exploration 74
5.5.1.2 SAE 3D Seismic Exploration 74
5.5.1.3 Hilcorp 3D Seismic – Lower Cook Inlet, Outer Continental Shelf 74
5.5.1.4 Military Detonations 75
5.5.2 Oil and Gas Exploration, Drilling, and Production Noise 75
5.5.2.1 ExxonMobil Alaska LNG, LCC 76
5.5.2.2 Furie Exploration Drilling 76
5.5.2.3 Hilcorp Oil and Gas 76
5.5.3 Vessel Traffic 77
5.5.4 Aircraft Sound 78
5.6 Sound and Habitat 79
5.7 Water Quality and Water Pollution 80
5.7.1 Petrochemical Spills 80
5.7.2 Wastewater Discharge 82
5.7.3 Mixing Zones 83
5.7.4 Stormwater Runoff 83

5.7.5 Aircraft De-icing 83
5.7.6 Ballast Water Discharges 84
5.7.7 Contaminants Found in Listed Species 85
5.8 Fisheries 86
5.8.1 Entanglement 88
5.8.2 Competition for Prey 89
5.9 Tourism 90
5.10 Direct Mortality 90
5.10.1 Subsistence Harvest 90
5.10.2 Poaching and Illegal Harassment 91
5.10.3 Stranding 91
5.10.4 Predation 92
5.10.5 Vessel Strikes 93
5.10.6 Research 94
5.11 Climate and Environmental Change 95
5.12 Environmental Baseline Summary 98
6. EFFECTS OF THE ACTION 99
6.1 Project Stressors 100
6.1.1 Minor Stressors on ESA-Listed Species and Critical Habitat 100
6.1.1.1 Acoustic disturbance from non-pile driving activities 100
6.1.1.2 Vessel Noise, Presence, and Strikes 101
6.1.1.3 Sea Floor Disturbance and Turbidity 103
6.1.1.4 Effects on Prey 104
6.1.1.5 Trash and Debris 105
6.1.1.6 Pollutants and Contaminants 105
6.1.2 Major Stressors on ESA-Listed Species and Critical Habitat 106
6.1.2.1 Acoustic Thresholds 106
6.2 Exposure Analysis 109
6.2.1 Ensonified Area 109
6.2.2 Marine Mammal Occurrence and Exposure Estimates 114
6.3 Response Analysis 122
6.3.1 Responses to Major Noise Sources (Pile Driving Activities) 123
6.3.1.1 Threshold Shifts 124
6.3.1.2 Non-auditory Physiological Effects 125
6.3.1.3 Behavioral Disturbance Reactions 126
6.3.1.4 Auditory Masking 128
6.3.2 Response Analysis Summary 129
7. CUMULATIVE EFFECTS 129
7.1 Vessel Traffic and Shipping 130
7.2 Fisheries (State of Alaska managed) 130

7.3 Pollution 130
7.4 Tourism 130
8. INTEGRATION AND SYNTHESIS 131
8.1 Cook Inlet Beluga Whale Risk Analysis 131
8.2 Mexico and Western North Pacific DPS Humpback Whales 133
8.3 Western DPS Steller Sea Lion Risk Analysis 134
9. CONCLUSION 136
10. INCIDENTAL TAKE STATEMENT 136
10.1 Amount or Extent of Take 137
10.2 Effect of the Take 138
10.3 Reasonable and Prudent Measures 138
10.4 Terms and Conditions 139
11. CONSERVATION RECOMMENDATIONS 140
12. REINITIATION OF CONSULTATION 140
13. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW 140
13.1 Utility 141
13.2 Integrity 141
13.3 Objectivity 141
14. REFERENCES 142

LIST OF TABLES

Table 1. Approximate numbers of structural features and sheet piles to be removed. 17
Table 2. Summary of NES1 project activities and quantities. 18
Table 3. Pile installation and removal methods and estimated durations. 20
Table 4. Estimated timing and duration by month of pile installation and removal. 20
Table 5. Shutdown and monitoring zones. 24
Table 6. Agency Contact Information. 31
Table 7. Listing status and critical habitat designation for species considered in this opinion. ... 35
Table 8. Beluga observations and monitoring effort in the POA area. 50
Table 9. Cook Inlet beluga whale recovery plan ten principal threats summary. 53
Table 10. PTS onset acoustic thresholds for Level A harassment (NMFS 2018). 108
Table 11. Underwater marine mammal hearing groups (NMFS 2018). 109
Table 12. NMFS User Spreadsheet inputs for calculating Level A and Level B isopleths. 112
Table 13. Level A and Level B harassment isopleths for pile driving activities. 113
Table 14. Marine mammal monitoring data used for beluga sighting rate calculations. 115
Table 15. Beluga monthly sighting rates for different spatially-based bins. 117
Table 16. Allocation of Level B harassment isopleths to sighting rate distance bins and associated beluga monthly sighting rates. 119
Table 17. Monthly pile driving hours, beluga sighting rates, and potential beluga Level B harassment exposures. 120
Table 18. Expected exposures of ESA-listed species. 122
Table 19. Incidental take of ESA-listed species authorized. 138

LIST OF FIGURES

Figure 1. Overview of North Extension Stabilization Step 1 project. 14
Figure 2. Components of the existing North Extension structure.. 16
Figure 3. Thumb and finger interlock for typical sheet pile in the bulkhead and tailwalls. 16
Figure 4. Wye interlock connecting bulkhead cell faces and tailwalls.. 16
Figure 5. Example of a H-beam sheet splitter.. 21
Figure 6. Example of hydraulic shears. 22
Figure 7. NES1 action area. 32
Figure 8. Designated Cook Inlet beluga critical habitat near the NES1 project site. 37
Figure 9. Alaska annual temperature 1900 to 2020. 42
Figure 10. Highest average sea surface temperature 1991-2020. 43
Figure 11. Cook Inlet beluga abundance estimates (circles), moving average (solid line), and 95 percent probability intervals (dotted lines and error bars; Goetz et al. 2023). Top panel includes 2021 survey data. 47
Figure 12. Areas occupied by Cook Inlet beluga whales during systematic aerial surveys. 49
Figure 13. Ranges of Western and Eastern DPS Steller sea lions and rookery and haulout sites. 59
Figure 14. Steller sea lion major rookeries and haulouts in the lower Cook Inlet area. 60
Figure 15. Oil and gas activity in Cook Inlet as of December 2022.. 69
Figure 16. Cook Inlet lease ownership by notification lessee. 70
Figure 17. Lease Sale 258 Blocks. 71
Figure 18. Percent of beluga CPAs in relation to distance from the NES1 project site and associated breakpoints determined by piecewise linear regression. 117

TERMS AND ABBREVIATIONS

µPa	Micro Pascal
2D	Two-Dimensional
3D	Three-Dimensional
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AKBMP	Alaska Beluga Monitoring Partnership
AKR	Alaska Region
ARRC	Alaska Railroad Corporation
AWTF	Anchorage Wastewater Treatment Facility
BA	Biological Assessment
BOEM	Bureau of Ocean Energy Management
CalTrans	California Department of Transportation
CFR	Code of Federal Regulations
cm	Centimeter
CPA	Closest Point of Approach
CY	Cubic Yard
dB re 1µPa	Decibel referenced 1 microPascal
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESCA	Endangered Species Conservation Act
°F	Fahrenheit
FERC	Federal Energy Regulatory Commission
FR	Federal Register
ft	Feet
hrs	Hours
Hz	Hertz
IHA	Incidental Harassment Authorization
in	Inches
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
JBER	Joint Base Elmendorf-Richardson
kHz	Kilohertz
km	Kilometers
km^2	Square Kilometers

LNG	Liquefied natural gas
MHHW	Mean Higher High Water
m	Meter
mi	Mile
mm	Millimeter
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MTRP	Marine Terminal Redevelopment Project
μPa	Micro Pascal
NEPA	National Environmental Policy Act
NES1	North Extension Stabilization Step 1 Project
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
ORPC	Ocean Renewable Power Company
Pa	Pascals
PAH	Polycyclic aromatic hydrocarbons
PAMP	Port of Anchorage Modernization Program
PBF	Physical or Biological Feature
PCB	Polychlorinated biphenyls
PCE	Primary Constituent Element
PCT	Petroleum and Cement Terminal
PK	Peak sound level
POA	Port of Alaska
PTS	Permanent Threshold Shift
RMS	Root Mean Square
s	Second
SEL	Sound Exposure Level
SPL	Sound pressure level
SUDEX	Susitna Delta Exclusion Zone
TL	Transmission Loss
TPP	Test Pile Program
TTS	Temporary Threshold Shift
USACE	U.S. Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
VGP	Vessel General Permit
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) 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.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different. New proposed rules were published in the Federal Register on June 22, 2023 (88 FR 40753).

In this document, the action agencies are NMFS Office of Protected Resources, Permits and Conservation Division (hereafter referred to as Permits Division) and U.S. Army Corps of Engineers (hereafter referred to as USACE). The NMFS Permits Division plans to issue an incidental harassment authorization (IHA) pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. § 1361 et seq.), to the Port of Alaska (POA) for harassment of marine mammals incidental to the proposed action of removal of the failed sheet pile structure within the North Extension area of the port. The USACE also plans to issue the POA a Clean Water Act section 404 permit for the proposed action (POA-2003-00502). The consulting agency for this proposal is NMFS's Alaska Region. This document represents NMFS's biological opinion (opinion) on the effects of this proposal on endangered and threatened species and designated critical habitat.

The opinion and ITS were prepared by NMFS Alaska Region in accordance with section 7(b) of the ESA (16 U.S.C. § 1536(b)), 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.

1.1 Background

This opinion is based on information provided in the IHA application, the proposed IHA (88 FR 76576, November 6, 2023), and the POA's Biological Assessment. Other sources of information relied upon include consultation communications (emails and virtual meetings), recent consultations completed in the same region, previous monitoring reports, and marine mammal surveys conducted in Cook Inlet. A complete record of this consultation is on file at NMFS's Anchorage, Alaska office.

The POA, located on Knik Arm in upper Cook Inlet, is Alaska's largest seaport and provides critical infrastructure for the state. The POA moves more than four million tons of material across its docks annually, which is consumed by 90 percent of Alaska's population. Existing POA marine-side infrastructure and facilities include three cargo terminals, two petroleum terminals, one dry barge berth, two miles of rail-spur connected to Alaska Railroad, and two floating, small-vessel docks, plus 220 acres of land facility located in Anchorage.[1]

The POA is modernizing its marine terminals through the Port of Alaska Modernization Program (PAMP). The PAMP is divided into five separate and independent phases. This opinion considers the North Extension Stabilization Step 1 phase (Figure 1), which is a stand-alone project with independent utility apart from the future PAMP phases. The North Extension, located north of the existing general cargo docks, is considered a failed structure. The structure presents safety hazards and logistical impediments to ongoing POA operations, and much of the upland area is currently unusable. The NES1 project will remove the failed sheet pile structure and reconfigure and realign the shoreline within the North Extension, including the conversion of approximately 13 acres of developed land back to intertidal and subtidal habitat within Knik Arm.

Ground improvement work to prepare the upland area and stabilize the existing fill for NES1 began in 2023. The ground improvements are occurring in the dry, landward of the existing structure and underneath the area where filter rock and armor rock will later be placed to stabilize the new shoreline.

This opinion considers the effects of pile driving activities, including vibratory and impact pile driving. These actions have the potential to affect the endangered Cook Inlet beluga whale (*Delphinapterus leucas*), threatened Mexico distinct population segment (DPS) humpback whale

[1] https://www.portofalaska.com/about-us/ Accessed May 2023.

(*Megaptera novaeangliae*), endangered Western North Pacific (WNP) DPS humpback whale, endangered Western DPS Steller sea lion (*Eumetopias jubatus*), and Cook Inlet beluga whale critical habitat. There is no critical habitat for Mexico or WNP DPS humpback whales or Steller sea lions in the action area. The nearest critical habitat for the Mexico and WNP DPS humpback whale is located over 200 kilometers (km) from the action area (86 FR 21082, April 21, 2021), as is the nearest Steller sea lion critical habitat (58 FR 45269, August 27, 1993). The Port of Alaska is considered outside the range of the proposed Sunflower sea star (*Pycnopodia helianthoides*).

1.2 Consultation History

- July 21, 2022 – NMFS AKR received the MMPA IHA application from the POA
- September 20, 2022 – NMFS AKR and NMFS Permits Division provided comments to POA
- December 27, 2022 – POA submitted a revised IHA application
- January 19, 2023 – NMFS AKR and NMFS Permits Division met with the POA to discuss the project description
- February 23, 2023 – NMFS AKR and NMFS Permits Division met with POA to discuss project acoustics
- March 28, 2023 – Early Review Team (ERT), with participants from the NMFS Permits Division and NMFS AKR, met to discuss the project
- March 29, 2023 – NMFS AKR and NMFS Permits Division met with POA to discuss Cook Inlet beluga whale take estimates
- April 5, 2023 – NMFS Permits Division emailed questions and comments from NMFS Permits Division and NMFS AKR on the revised December 2022 IHA application
- July 31, 2023 – POA submitted a revised IHA application
- August 9, 2023 – NMFS Permits Division emailed questions and comments from NMFS Permits Division and NMFS AKR on the revised July 2023 IHA application
- August 31, 223 – POA submitted a revised IHA application
- September 1, 2023 – NMFS AKR received draft Biological Assessment (BA) from POA
- September 7, 2023 – NMFS Permits Division determined the IHA application is adequate and complete
- September 21, 2023 – POA submitted a revised IHA application
- October 3, 2023 – NMFS AKR received a revised draft BA from the POA
- October 12, 2023 – NMFS AKR received the BA and request for consultation from USACE
- October 20, 2023 – NMFS AKR initiated consultation
- October 30, 2023 – Request for consultation, draft IHA, and proposed Federal Register Notice (FRN) received from the NMFS Permits Division
- November 6, 2023 – Proposed IHA published in the Federal Register
- December 7, 2023 – NMFS AKR provided POA with a copy of the draft biological opinion
- December 8, 2023 – POA responded that there were no comments on the draft opinion

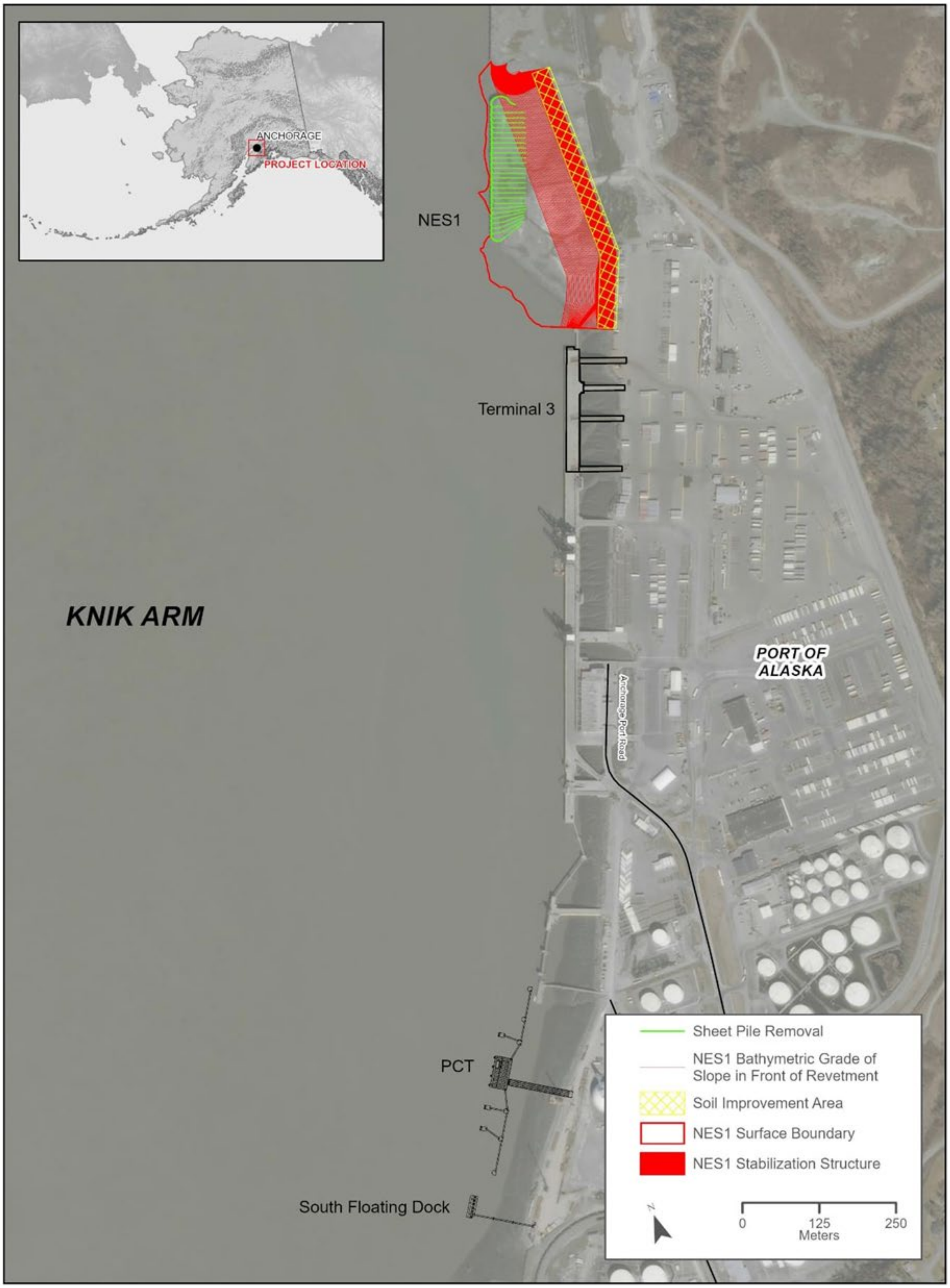

Figure 1. Overview of North Extension Stabilization Step 1 project.

2. DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas. 50 C.F.R. § 402.02.

This opinion considers the effects of the North Extension Stabilization Step 1 project (NES1), which involves removal of the failed sheet pile structure and reconfiguration and realignment of the shoreline within the North Extension. The POA sits on the industrial waterfront of Anchorage, just south of Cairn Point and north of Ship Creek at 61.250°N and 149.867°W.

The action is expected to occur over a period of 12 months. Pile driving will occur intermittently during the work period, for durations of minutes to hours at a time. Pile installation and removal will occur over approximately 246.5 hours (hrs) on 110 nonconsecutive days within the construction window.

The following description of the proposed action derives primarily from the IHA application, the proposed IHA (88 FR 76576, November 6, 2023), and the Biological Assessment.

2.1.1 Proposed Activities

The existing North Extension bulkhead structure is an OPEN CELL SHEET PILE™ (OCSP™) design. The OCSP™ bulkhead is an earthen-filled retaining structure comprised of 29 interconnected open cells, each approximately 8 m wide, with 30 tailwalls that are up to 61 m long (Figure 2). Each cell is about 20 sheets wide across the face, and each tailwall consists of approximately 118 sheet piles that extend landward into the filled area, orthogonal to the sheet piles along the face. Two z-pile closure walls close the gaps between structures, one on each end of the bulkhead.

The sheet piles interlock through a series of thumb-finger joints or interlocks (where two sheet piles are connected along their length; Figure 3) along the cell faces and tailwalls. Wye joints occur where three sheet piles are connected at the interface between two neighboring sheet pile cell faces and the adjoining tailwall (Figure 4). The exact number of sheet piles in the existing structure is not known with certainty, but the POA estimates that 4,216 sheet piles will be removed (Table 1).

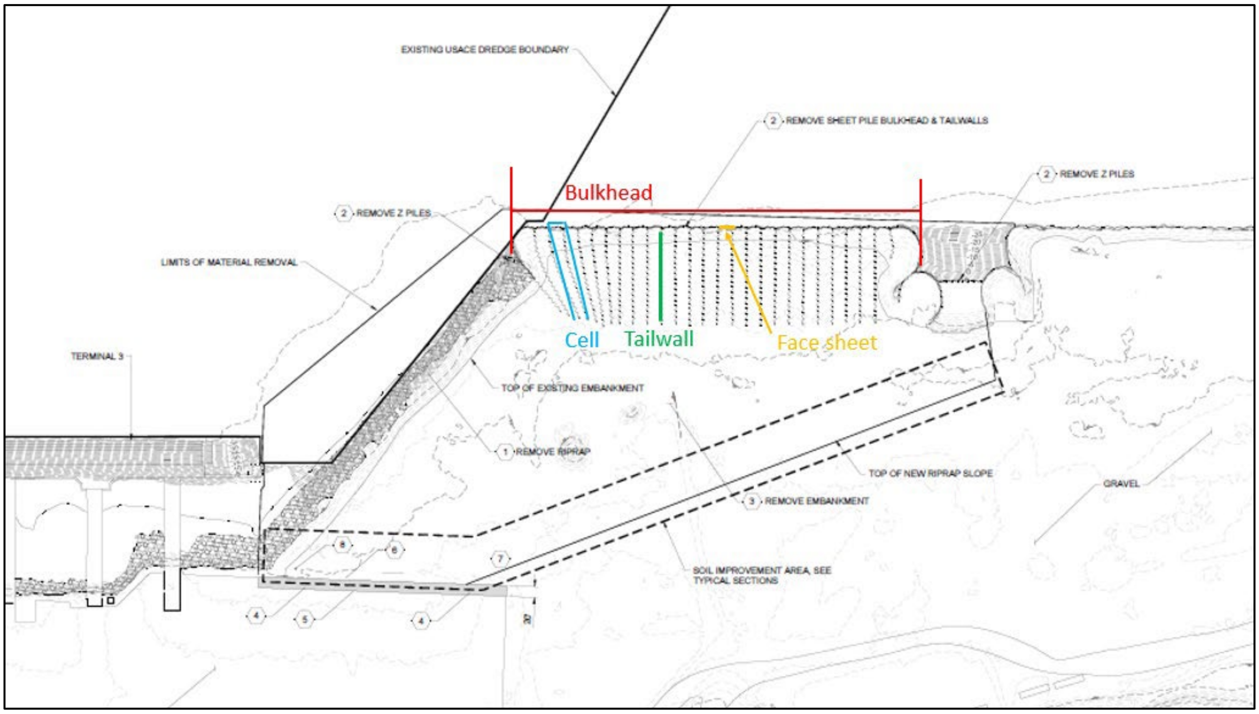

Figure 2. Components of the existing North Extension structure.

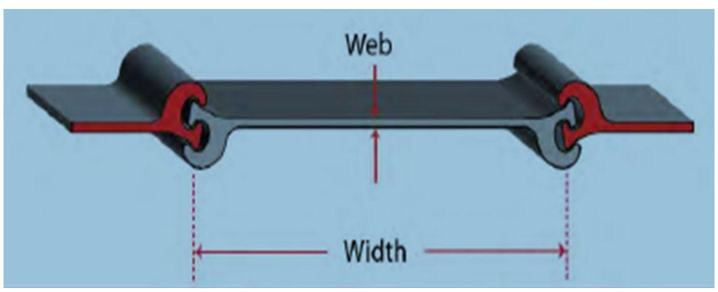

Figure 3. Thumb and finger interlock for typical sheet pile in the bulkhead and tailwalls.

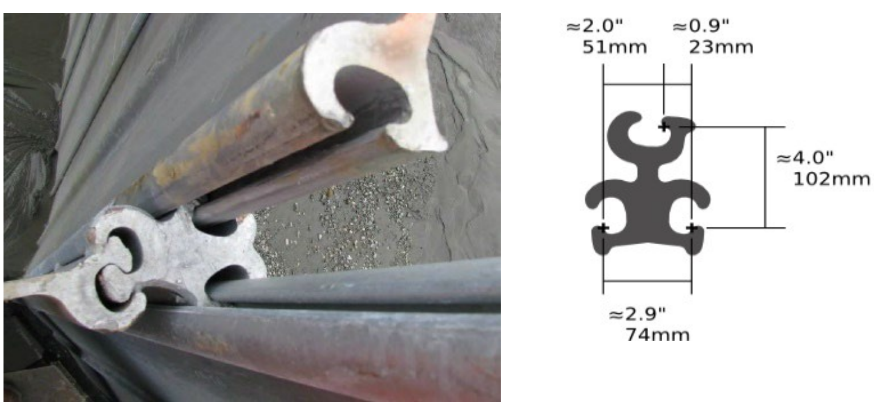

Figure 4. Wye interlock connecting bulkhead cell faces and tailwalls.

Table 1. Approximate numbers of structural features and sheet piles to be removed.

Structural Feature	# of Structures	Average # of Sheets per Structure	Sheet Pile Type	Pile Size	Total # of Sheets
Tailwalls	30	118	PS 27.5 and PS 31	19.69 inches	3,536
Cell Faces (Bulkhead)	29	20	PS 27.5 and PS 31	19.69 inches	568
Closure Walls	2	56	PZC26 Z-piles	27.88 inches	112
				Total	4,216

Project activities include the following tasks:

- Dredging and offshore disposal of approximately 1.35 million cubic yards (CY) of material down to -39 feet (ft) MLLW
- Excavation of 115,000 CY of material
- Demolition and removal of the existing North Extension sheet pile structure
- Shoreline stabilization, including placement of granular fill, filter rock, and armor rock along the new face of the shoreline

The NES1 project will remove approximately 274 m (or half) of the North Extension structure starting from the southern end and working north. Demolition will be accomplished through excavation and dredging of impounded soils (fill material), and removal of the existing sheet piles. The project will also stabilize the remaining portion of the North Extension, and create a new shoreline that is structurally and seismically stable and balances the preservation of uplands created in the past while addressing the formation of unwanted sedimentation within the USACE Anchorage Harbor. Approximately 13 acres of intertidal and subtidal habitat will be re-created.

The majority of the demolition work will occur from the water side in order to eliminate safety hazards from unexpected movements of the sheet piles and/or fill material. Temporary piles will also be installed to stabilize the face sheets. NES1 activities and quantities are summarized in Table 2.

The POA has provided a project description with conservative predictions and estimates based on the best available information at this time; however, the Construction Work Plan has not yet been finalized. Construction and demolition means and methods are likely to be refined for safety and design elements through adaptive management measures once activities commence and as the project advances. There are several risks to consider: existing sheet piles and their interlocks are in poor condition, many of the sheet piles may be damaged and bound up, and there are stability concerns with the impounded material and failed OCSP™ structure. The strong currents and large tidal swings that occur in Knik Arm are also risk factors that will be accounted for when planning and executing the work.

Table 2. Summary of NES1 project activities and quantities.

Location	Type of Activity	Size and Type	Estimated Amount or #
In-water	Dredging of fill material	Granular fill	1,350,000 CY
	Vessel transit and disposal of dredged fill		
	Vibratory pile driving	24-inch or 36-inch temporary steel piles	81 installations, 81 removals
In-water, On land	Removal of sheet piles in vertical panels: vibratory and impact pile driving, direct pull	19.69 inch sheet piles	4,216
	Cutting piles with sheet splitter (vertical)	19.69 inch sheet piles	Unknown
	Cutting piles with shears or torch (horizontal)[1]	19.69 inch sheet piles	Unknown
	Slope construction	Bedding, filter rock, armor stone	60,500 CY
On land	Excavation of fill material	Granular fill and rock	115,000 CY

[1] Most of the waterside face and tailwall sheets will be cut in the dry to improve operational safety. Deploying divers or underwater shear equipment will be the last resort for removing sheet piles.

2.1.1.1 Excavation

Excavation will occur on land with loaders and excavators. Removing the top portion of fill material will open up work for initial sheet pile cutting and removal. Some of the pressure will be relieved along the sheet wall face and the tops of the sheet pile will become exposed. This will mitigate the risk of damaging sheets while dredging with a clamshell bucket; sheet pile extraction will be easier if the sheets are undamaged. The removal elevation will remain above +15 ft MLLW in order for the land equipment to reach the excavation depth with the groundwater and tidal elevations, and ensure that the removed material will be in good condition. The material removed will be stockpiled at the POA for future use.

2.1.1.2 Dredging and Disposal

Once the top portion of fill along the face of the wall has been removed by landside excavation, dredging of the material within the cells will begin while maintaining the allowable fill differential between adjacent cells to preserve structural integrity. Dredging will be performed with a derrick barge using a clamshell bucket, and will likely occur for 24 hours per day. One barge will perform the dredging associated with the sheet pile removal, working concurrently and in support of the crane barge removing the sheets. Another barge will perform dredging in the remaining project area. This barge will start with removing the existing armor rock on the south slope and work its way north behind the OSCP™ bulkhead.

Removal of approximately 1.35 million CY of fill material from below the high tide line down to -39 ft MLLW will re-create approximately 13 acres of intertidal and subtidal habitat, returning them to their approximate original slope and shoreline configuration. Dredged material will be placed on a dump barge and taken by tug boat for disposal at the Anchorage Harbor Open Water Disposal Site, which is the authorized USACE offshore disposal area used by the POA. The disposal site is located within the exemption area of the designated Cook Inlet beluga whale critical habitat.

2.1.1.3 Pile Installation and Removal

Following excavation and initial dredging work, in-water pile installation and removal is expected to occur over approximately 246.5 hours on 110 nonconsecutive days (Table 3). The exact sequence of demolition and construction is not known; however, an estimated schedule of sheet pile removal and temporary stability template pile installation and removal is shown in Table 4.

The sheet pile removal process will begin with the vibratory installation of stability templates along the face of the sheet pile structure. The temporary stability template piles will likely be 24-inch steel pipe piles; however, 36-inch steel pipe piles may be used instead. Twenty-seven temporary stability templates will support about one-third of the bulkhead sheet pile wall during removal of the impounded material. A crane barge will install the templates before dredging deeper than the allowable elevation determined by the engineer. The templates reinforce the sheets as material is dredged and hold them upright to prohibit any sheet deformation, which improves the efficiency and effectiveness of sheet pile removal. The templates also minimize the need to perform horizontal cuts of the sheet piles at multiple elevations, including underwater. The 27 temporary piles will be removed and re-installed as work moves along the bulkhead for a total of a total of 81 installations and 81 removals.

Construction will begin on the southern end of the sheet pile structure and work north along the sheet wall face, installing templates and dredging fill material while managing fill elevations from cell to cell. Fill material will continue to be removed until a cell has been dredged down to -12 m MLLW adjacent to the face sheets and all pressure of the fill material on the face has been relieved. At this point, the crane barge will begin removing the sheet piles, starting with the face sheets.

Some sheet piles from the tailwalls will be removed in the dry, potentially during excavation, depending on construction sequencing and tide heights. Removal in the dry will be maximized as feasible, and it is estimated that approximately 20 to 30 percent of sheet piles will be removed in the dry. Removal of sheet piles by direct pulling will also be maximized as feasible. The sheet piles may be dislodged out of interlock by lifting or direct pulling after fill material and impounded soils have been excavated or dredged from both sides.

While some of the sheet piles and sheet pile sections will be removed by direct pulling and/or in the dry, it is expected that some sheet piles and sheet pile sections will need to be removed with a vibratory hammer in water. Sheet piles may not be extracted easily if soil adheres to the sheet piles along the embedded length. It is also possible that competent portions of the interlocks will resist movement, or that interlocks that are bent or damaged by shearing will be difficult to separate and require shaking with a vibratory hammer. Vertical cuts to split the sheet piles into panels will be made with a sheet splitter if the interlocks do not release (Figure 5). The splitter will be used in conjunction with a vibratory hammer, and it is expected that splitting will produce the same or similar sound levels to a vibratory hammer used without the splitter attachment. The POA combined use of a vibratory hammer to remove sheet piles and use of a splitter into a single category (i.e., vibratory hammer removal).

Table 3. Pile installation and removal methods and estimated durations.

Pile Type	Pile Size	Structural Feature	Estimated # of Piles in the Water	Average Vibratory and/or Splitter Duration	Maximum Impact Strikes Per Day	Total Duration in Water (hrs)	Piles per Day (Range)	Estimated # of Days
PS 27.5 and PS 31 Sheets	19.69 inch	Tailwalls	2,267*	2 hrs/day	150	157	50 (10 to 100)	46
PS 27.5 and PS 31 Sheets	19.69 inch	Cell Faces (Bulkhead)	568	2 hrs/day	150	41	30 (10 to 60)	19
PZC26 Sheets	27.88 inch	Closure Walls	112	2 hrs/day	150	8	50 (10 to 100)	3
Steel Pipe Installation	24- or 36-inch	Temporary Stability Templates	81	15 min/pile	0	20.25	4 (2 to 12)	21
Steel Pipe Removal	24- or 36-inch		81	15 min/pile	0	20.25	4 (2 to 12)	21
					Total	246.5	-	110

* Approximately 20 to 30 percent of the 4,216 sheet piles will be removed in the dry.

Table 4. Estimated timing and duration by month of pile installation and removal.

Activity		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Installation 24- or 36-inch Stability Template Pile	Piles	27	14	14	10	10	3	3	0	81
	Hours	6.75	3.50	3.50	2.50	2.50	0.75	0.75	0	20.25
Removal 24- or 36-inch Stability Template Pile	Piles	0	27	13	13	13	10	4	1	81
	Hours	0	6.75	3.25	3.25	3.25	2.50	1	0.25	20.25
Vibratory Removal Sheet Pile	Piles	-	-	-	-	-	-	-	-	-
	Hours	10	45	60	60	13	12	4	2	206
	Total hours	16.75	55.25	66.75	65.75	18.75	15.25	5.75	2.25	246.50

Figure 5. Example of a H-beam sheet splitter.

During vibratory removal, a vibratory hammer will be suspended from a crane and connected to a powerpack. The extractor jaw will be hydraulically locked onto the web of the sheet pile, and the pile will be vibrated as upward vertical force is applied. Ideally, piles will slide within the interlock and separate from adjacent piles. However, the pile may bind, and multiple piles may be dislodged from the original installed position or the pile web (the thin, flat part between the interlocks) may tear and partially rip the pile, necessitating the application of vertical force to a neighboring pile.

The POA estimates that the vibratory hammer will be required for an average of approximately five minutes to remove each sheet pile section. It is unknown how many sheet piles may be included in a section; the POA expects this number to vary widely. If sheet piles remain seized in the sediments and cannot be loosened or broken free with a vibratory hammer, they may be dislodged with an impact hammer. Use of an impact hammer is expected to be uncommon, with a limited number of up to 150 strikes (an estimated 50 strikes per pile for up to three piles) on any individual day, or approximately five percent of active hammer duration for sheet piles.

2.1.1.3.1 Alternative Methods of Sheet Pile Removal

Alternative means of sheet pile removal include dredging or excavation to further reduce pile embedment, as well as cutting sheet piles. Sheet piles will be removed in one piece, without cutting, when feasible. When sheet piles need to be cut, they will be cut out of the water, when feasible.

Hydraulic shears may be used to cut sheet piles both in and out of the water (Figure 6). Many styles of hydraulic shears are available, and the exact model that will be used for the project has not been selected. Shears could be configured to operate in a horizontal or vertical orientation. The jaw depth could range up to 142 centimeters (cm) or more, and hydraulic shears will be able to cut sheet piles along their width, including the thumb-finger interlock joints and the wye joints. A single closure of the shears may sever one or multiple sheet piles, depending on the model and jaw depth. A single cut may require up to 2 minutes for the shears to close, but likely less.

Figure 6. Example of hydraulic shears.

Sheet piles may also be cut using underwater ultrathermic cutting torches. Underwater ultrathermic cutting is performed by commercial divers using hand-held equipment, often the Broco® Underwater Cutting System, to cut or melt through ferrous and non-ferrous metals. These systems operate through a torch-like process, initiated by applying a melting amperage to a steel tube packed with alloy steel rods, sometimes mixed with aluminum rods to increase the heat output. The process is typically relatively fast and efficient, cutting through approximately 5 to 10 cm per minute, depending upon the number and skill of the divers deployed. Piles will need to be secured to prevent the severed piles from falling into the inlet. Dive times may be limited to approximately two to three hours per high- and low-tide event, depending upon the tide cycle and the ability of divers to efficiently cut sheets while holding position during high current periods.

Once the face sheets have been removed, the crane barge will remove the stability templates for use on other cells. At this point, the tailwalls are independent walls with only fill material between them. The crane barge will extract as many tailwall sheets as possible until additional relief dredging is required to allow for vibratory removal. The crane barge will then continue north while the dredge rig falls back to continue dredging between the sheets. The face wall and tailwall sheets will be removed from south to north until demolition is complete and the OCSP™ structure has been removed.

2.1.1.4 Shoreline Stabilization

After the existing sheet pile structure has been removed, NES1 will stabilize the remaining portion of the North Extension. The project will create an end-state embankment with a top elevation of 38.0 ft MLLW, sloping to a toe elevation of approximately -40.0 ft MLLW. The lower portion of the embankment slope from -40.0 ft MLLW to approximately 0 ft MLLW will be constructed with a 6 horizontal to 1 vertical (6H:1V) slope and will be unarmored. A grade-break will occur above these elevations as the slope will transition to a 2 horizontal to 1 vertical (2H:1V) slope armored rock revetment, consisting of armor stone placed on a layer of filter rock and granular fill. Placement of armor rock requires good visibility of the shore as each rock is placed carefully to interlock with surrounding armor rock. Placement of armor rock will occur in the dry at low tide levels when feasible; however, some placement of armor rock, filter rock, and granular fill will occur in water. The quantities of armor rock and fill provided in Table 2 are estimates and may be adjusted as the design advances. Approximately 13 acres of intertidal and subtidal habitat will be re-created.

2.1.2 Mitigation Measures

The action includes the following mitigation measures, which are outlined in the NMFS Permits Division's proposed IHA for the NES1 project (88 FR 76576, November 6, 2023) and are part of the Marine Mammal Monitoring and Mitigation Plan submitted by the POA.

Mitigation Measures

1. Pile driving will occur during daylight hours only.

2. Two vibratory hammers with or without splitters will not be used simultaneously.

3. The POA will employ PSOs per the Marine Mammal Monitoring and Mitigation Plan described in Section 5 of the IHA. The POA must monitor the project area to the maximum extent possible based on the required number of PSOs, required monitoring locations, and environmental conditions.

4. The POA will conduct briefings for construction supervisors and crews, the monitoring team, and POA staff prior to the start of all in-water pile installation and removal, and when new personnel join the work, in order to explain responsibilities, communication procedures, the marine mammal monitoring protocol, and operational procedures.

5. Marine mammal monitoring will take place from 30 minutes prior to initiation of in-water pile installation (i.e., pre-clearance monitoring) and removal through 30 minutes post-completion of pile installation and removal. For use of a barge-mounted excavator or dredge, hydraulic shears, and ultrathermic cutting torches, marine mammal monitoring will take place from 15 minutes prior to initiation of these activities through 15 minutes post-completion.

6. Pre-clearance monitoring will be conducted during periods of visibility sufficient for the lead PSO to determine that the shutdown zones (Table 5) are clear of marine mammals. Pile installation or removal will commence following 30 minutes of observation when the determination is made that the shutdown zones are clear of marine mammals.

7. For beluga whales, the monitoring zone for pile installation and removal must be fully visible for 30 minutes before the zone can be considered clear of beluga whales. Pile installation and removal will commence when PSOs have declared the monitoring zone clear of beluga whales or the mitigation measures developed specifically for beluga whales are satisfied.

8. A soft start will be used for impact pile installation. Soft start requires contractors to provide an initial set of strikes at reduced energy, followed by a thirty-second waiting period, then two subsequent reduced energy strike sets. A soft start must be implemented at the start of each day's impact pile driving, any time pile driving has been shutdown or

delayed due the presence of a marine mammal, or at any time following cessation of impact pile driving for a period of thirty minutes or longer.

9. If a marine mammal is entering or is observed within an established shutdown zone, in-water pile installation and removal, use of hydraulic shears or ultrathermic cutting torches, or dredging will be halted or its start will be delayed. In-water pile installation and removal will not commence or resume until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone and on a path away from such zone, or 15 minutes (non-beluga whales) or 30 minutes (beluga whales) have passed without subsequent detections. Use of hydraulic shears or ultrathermic cutting torches and dredging will not commence or resume until the animal has voluntarily left and been visually confirmed beyond the shutdown zone and on a path away from such zone or 15 minutes (all species) have passed without subsequent detections.
10. For in-water demolition involving hydraulic shears or ultrathermic cutting torches, if a marine mammal comes within 100 m, the POA will cease operations until the marine mammal has moved beyond 100 m from the activity. Use of hydraulic shears and ultrathermic cutting torches will not commence or recommence if a marine mammal is inside the 100-meter shutdown zone.
11. During in-water dredging or use of a barge-mounted excavator in water, if a beluga whale comes within 50 m of the dredge when it is actively dredging, the POA will cease operations until the beluga whale has moved beyond 50 m from the dredge. Dredging will not commence or recommence if a beluga whale is inside the 50-meter shutdown zone. Dredging will cease for non-beluga-whale species if they approach within 10 m of the active dredge.
12. During in-water demolition/construction, if an ESA-listed species (beluga whale, humpback whale, Steller sea lion) comes within 100 meters of a moving vessel, the POA will reduce vessel speed to the minimum level required to maintain steerage and safe working conditions.

Table 5. Shutdown and monitoring zones.

Activity	**Pile Size/ Type**	**Shutdown Zone (m)**			**Monitoring Zone (m)**
		LF Cetaceans	**MF Cetaceans**	**Otariids**	
Vibratory Installation	24-inch	20	2,300	10	2,300
	36-inch	30	4,600	10	4,600
Vibratory Removal	24-inch	50	6,900	10	6,900
	36-inch	20	1,700	10	1,700
	Sheet Pile	10	2,000	10	2,000
Impact Removal	Sheet Pile	160	900	10	900
Hydraulic Shears	-	100	100	100	100
Ultrathermic Cutting Torches	-	100	100	100	100
Dredging	-	10	50	10	50
Vessel Transit	-	100	100	100	100

13. If pile installation or removal is delayed or halted due to the presence of a marine mammal, the activity may not commence or resume until either the animal has voluntarily exited and been visually confirmed beyond the shutdown zone or 15 minutes (30 minutes for beluga whales) have passed without redetection of the animal. Marine mammal behavior will be monitored and documented during the sighting.

14. On a given day, if marine mammal monitoring ceases, but in-water pile installation and removal is scheduled to resume, PSOs will follow the pre-clearance monitoring protocol as described above, including a 30-minute clearance scan of the monitoring zone for beluga whales. If marine mammal monitoring ceases but in-water use of hydraulic shears or ultrathermic cutting torches is scheduled to resume, PSOs will follow the pre-activity monitoring protocol as described above, including a 15-minute clearance scan of the 100-meter shutdown zone.

15. Cook Inlet beluga whale pile installation and removal delay and shutdown protocol

    a. Prior to the onset of in-water pile installation or removal, should a beluga whale(s) be observed within the shutdown zone, in-water pile installation or removal will be delayed. In-water pile installation and removal will not commence until the animal has voluntarily traveled at least 100 m beyond the shutdown zone and is on a path away from the zone, or the beluga whale has not been resighted within 30 minutes.

    b. If in-water pile installation or removal has commenced and a beluga whale(s) is observed within or likely to enter the shutdown zone, pile installation and removal will be delayed. In-water pile installation and removal will not commence until the beluga whale has voluntarily traveled at least 100 m beyond the shutdown zone and is on a path away from the zone, or the whale has not been resighted within 30 minutes.

    c. If during in-water installation or removal of piles, PSOs can no longer effectively monitor the entirety of the beluga whale shutdown zone due to environmental conditions (e.g., fog, rain, wind), in-water pile installation and removal will continue only until the current segment of pile is installed or removed. No additional sections of an in-water pile may be installed or removed until conditions improve such that the shutdown zone can be effectively monitored. If the shutdown zone cannot be monitored for more than 15 minutes, the entire zone will be cleared again for 30 minutes prior to in-water pile installation and removal.

16. If a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized takes are met, is observed approaching or within the monitoring zone, in-water pile installation and removal will shut down immediately. In-water pile installation and removal will not resume until the animal has been confirmed to have left the area or 30 minutes have elapsed since the animal was last seen within the monitoring zone.

Monitoring Measures

17. PSOs must be independent and have no other assigned tasks during monitoring periods.

18. A designated Lead PSO must always be on site at each station during in-water work, and will be responsible for implementing the POA's Marine Mammal Monitoring Plan for all in-water pile installation and removal, use of hydraulic shears, and ultrathermic cutting torches. The lead observer must have prior experience performing the duties of a PSO during construction activity pursuant to a NMFS-issued IHA, letter of concurrence, or biological opinion.

19. PSOs that do not have prior experience performing the duties of a PSO during construction activity pursuant to a NMFS-issued IHA, letter of concurrence, or biological opinion may substitute other relevant experience, education (degree in biological science or related field), or training for prior experience performing the duties of a PSO. But may not be a lead PSO.

20. PSOs must have the following additional qualifications:

    a. Ability to conduct field observations and collect data according to assigned protocols.

    b. Experience or training in the field identification of marine mammals, including the identification of behaviors.

    c. Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations.

    d. Writing skills sufficient to record required information including but not limited to the number and species of marine mammals observed; dates and times when in-water construction activities were conducted; dates, times, and reason for implementation of mitigation (or why mitigation was not implemented when required); and, marine mammal behavior.

    e. Ability to communicate orally, by radio or in person, with project personnel to provide real-time information on marine mammals observed in the area, as necessary.

21. PSOs must be approved by NMFS prior to beginning any activity subject to this opinion.

22. The POA must establish PSO stations at two to three locations from which PSOs can effectively monitor the entirety of the largest shutdown zone for the current activities.

23. PSO stations must be positioned at the best practical vantage points that are determined to be safe.

    a. At least one of the PSO stations will be able to fully observe the shutdown zones.

Likely locations include the Anchorage Public Boat Dock at Ship Creek to the south of the proposed project site, and a location to the north of the project site, such as the northern end of POA property near Cairn Point or at Port MacKenzie across Knik Arm.

b. Temporary staffing of a northerly monitoring station during peak marine mammal presence time periods and/or when shutdown zones are large will be considered.

24. PSOs stations should be elevated platforms at least 8.5 ft high that that can support up to three PSOs and their equipment (e.g., shipping containers or a similar base). The platforms must be stable enough to support use of a theodolite and must be located to optimize the PSO's ability to observe marine mammals and the harassment zones.

25. Each PSO station must have at least two PSOs on watch at any given time; one PSO will be observing, and one PSO will be recording data (and observing when there are no data to record).

    a. Teams of three PSOs will include one PSO observing, one PSO recording data (and observing when there are no data to record), and one PSO resting.

    b. PSOs must be in constant real-time communication with each other and with construction crews to convey information about marine mammal sightings, locations, directions of movement, and communicate calls for pile driving shutdowns or delays.

    c. If the POA is conducting non-NES1-related in-water work that includes PSOs, the NES1 PSOs must be in real-time contact with those PSOs, and both sets of PSOs must share all information regarding marine mammal sightings with each other.

26. PSOs will observe for no more than 4 hours at a time without a break and no more than 12 hours per day.

27. Crew members aboard the NES1 project dredge will conduct marine mammal observations and implement the 50-meter shutdown zone for beluga whales and 10-meter shutdown zone for other species.

    a. When PSOs are concurrently implementing the marine mammal monitoring and mitigation program for the NES1 project, PSOs will communicate and coordinate to share information with the dredge crew. When dredging takes place when no other in-water work is anticipated, dredge crew members will implement the marine mammal monitoring program for the dredge independently.

28. PSOs will use a combination of equipment to perform marine mammal observations and to verify the required monitoring distance from the project site, including 7x50 binoculars, 20x/40x tripod mounted binoculars, 25x150 "big eye" tripod mounted binoculars, and theodolites.

29. PSOs must record all observations of marine mammals, regardless of distance from the pile being driven. PSOs will document any behavioral reactions in concert with distance from piles being driven or removed.

Reporting

The POA is required to:

30. Submit interim weekly and monthly marine mammal monitoring reports during the NES1 construction season. These reports must include a summary of marine mammal species and behavioral observations, pile driving shutdowns or delays, and construction work completed. They also must include an assessment of the amount of construction remaining to be completed (i.e., the number of estimated hours of work remaining), in addition to the number of potential Cook Inlet beluga whale takes to date.

31. Alert NMFS AKR when the number of Cook Inlet beluga whale takes reaches 80 percent of those authorized (i.e., when the POA estimates there have been a potential 58 takes by Level B harassment). Weekly marine mammal monitoring reports will assist with the tracking of take numbers.

32. Submit a draft final report on all marine mammal monitoring conducted under the IHA within 90 calendar days of the completion of monitoring. A final report shall be prepared and submitted within 30 days following resolution of comments on the draft report from NMFS. This report must contain the informational elements described in the Marine Mammal Monitoring Plan, including, but not limited to:

    a. Dates and times (begin and end) of all marine mammal monitoring;

    b. PSO locations during marine mammal monitoring;

    c. Construction activities occurring during each daily observation period, including how many and what type of piles were installed or removed and by what method (i.e., impact or vibratory, the total duration for vibratory installation and removal, and the total number of strikes for each pile during impact driving);

    d. Weather parameters and water conditions during each monitoring period (e.g., wind speed, percent cover, visibility, sea state);

    e. Name of the PSO who sighted the animal(s) and PSO location, and project activity at the time of sighting;

    f. Time of sighting;

    g. The number of marine mammals observed, by species;

    h. Age and sex class, if possible, of all marine mammals observed;

i. Distances and bearings of each marine mammal observed relative to the pile location and if pile driving or removal was occurring at the time of sighting;

j. Animal's closest point of approach to the in-water sound-producing activity, and estimated time spent within the harassment zone;

k. Group spread and formation (for belugas only);

l. Description of any marine mammal behavior observations (e.g., feeding or traveling), including an assessment of behavioral responses thought to have resulted from the activity (e.g., no response or changes in behavioral state such as ceasing feeding, changing direction, flushing, or breaching);

m. Number of individuals of each species (differentiated by month as appropriate) detected within the harassment and shutdown zones, and estimates of number of marine mammals taken, by species (a correction factor may be applied to total take numbers, as appropriate);

n. Detailed information about any implementation of any mitigation triggered (e.g., shutdowns and delays), a description of specific actions that ensued, and resulting behavior of the animal, if any; and

o. Description of attempts to distinguish between the number of individual animals taken and the number of incidences of take, such as ability to track groups or individuals.

33. Report unauthorized take:

a. If a listed marine mammal is determined by the PSO to have been disturbed, harassed, harmed, injured, or killed (e.g., a listed marine mammal(s) is observed entering a shutdown zone before operations can be shut down, or is injured or killed as a direct or indirect result of this action), the incident will be reported to NMFS AKR within one business day, with information submitted to akr.section7@noaa.gov. These PSO records will include:

i. All information to be provided in the final report (*Measure #32*);

ii. Date, time, and location of each event (provide geographic coordinates);

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

iv. Number of animals of each threatened and endangered species affected;

v. Description of the event;

vi. Time the animal(s) was first observed or entered the shutdown zone, and, if known, the time the animal was last seen or exited the zone, and the fate of the animal;

vii. Mitigation measures implemented prior to and after the animal was taken;

viii. If a vessel struck a marine mammal, the contact information for the PSO on duty, or the contact information for the individual piloting the vessel if there was no PSO on duty;

ix. Description of all marine mammal observations and active sound source use in the 24 hours preceding the incident; and

x. Photographs or video footage of the animal(s) (if available).

b. Activities must not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with POA to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA and ESA compliance. The POA may not resume their activities until notified by NMFS.

34. Report stranded, injured, sick or dead marine mammals:

a. If PSOs observe an injured, sick, or dead marine mammal (i.e., stranded marine mammal), they will notify the Alaska Marine Mammal Stranding Hotline at 877-925-7773. The PSOs will submit photos and available data to aid NMFS in determining how to respond to the stranded animal. If possible, data submitted to NMFS in response to stranded marine mammals will include date/time, location of stranded marine mammal, species and number of stranded marine mammals, description of the stranded marine mammal's condition, event type (e.g., entanglement, dead, floating), and behavior of live-stranded marine mammals.

35. Report illegal activities:

a. If PSOs observe marine mammals being disturbed, harassed, harmed, injured, or killed (e.g., feeding or unauthorized harassment), these activities will be reported to NMFS Alaska Region Office of Law Enforcement at 1-800-853-1964.

Table 6. Agency Contact Information.

Reason for Contact	**Contact Information**
Request S7 Consultation	AKR.PRD.Section7@noaa.gov
Consultation Questions & Unauthorized Take	AKR.PRD.Section7@noaa.gov Kathleen Leonard: (kathleen.leonard@noaa.gov)
Reports & Data Submittal	AKR.PRD.Section7@noaa.gov (Include AKRO-2022-03630 in subject line)
Stranded, Injured, Entangled or Dead Marine Mammal *(not related to project activities)*	NOAA Fisheries Stranding Hotline (24/7 coverage) 1-877-925-7773
Oil Spill & Hazardous Materials Response	U.S. Coast Guard National Response Center 1-800-424-8802 AKRNMFSSpillResponse@noaa.gov
Illegal Activities *(not related to project activities; e.g., feeding, unauthorized harassment, or disturbance to marine mammals)*	NMFS Office of Law Enforcement (AK Hotline) 1-800-853-1964
In the event that this contact information becomes obsolete	NMFS Anchorage Main Office: 907-271-5006 NMFS Juneau Main Office: 907-586-7236

2.2 Action Area

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

NMFS defines the action area for this consultation as the area within which project-related noise levels exceed 122.2 dB re 1 µPa root mean square (rms), and are expected to approach ambient noise levels (i.e., the point where no measurable effect from the project would occur; See Section 6.1.2.1). To define the action area, we considered the maximum diameter and type of piles, the pile-driving methods, and empirical measurements of noise. Received sound levels associated with vibratory removal of temporary 24-inch steel piles are expected to decline to 122.2 dB re 1µPa rms within 6,861 m of the source (Figure 7). See the Acoustic Threshold section for more information on the factors included in this calculation.

Figure 7. NES1 action area.

3. APPROACH TO THE ASSESSMENT

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

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

Under NMFS's regulations, the destruction or adverse modification of critical habitat means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species (50 CFR § 402.02).

Prior to 2016, designations of critical habitat used the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (81 FR 7414; February 11, 2016) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, our use of the term PBF also applies to Primary Constituent Elements and essential features.

We use the following approach to determine whether the proposed action described in Section 2 of this opinion is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify those aspects (or stressors) of the proposed action that are likely to have effects on listed species or critical habitat. As part of this step, we identify the action area – the spatial and temporal extent of these effects.

- Identify the range-wide 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 range-wide 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 action. 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 sex 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 PBFs. 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 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 to the action.

4. RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

Three species (four DPSs) of ESA-listed marine mammals under NMFS's jurisdiction may occur in the action area. Designated critical habitat for the Cook Inlet beluga whale also occurs in the action area. This opinion considers the effects of the proposed action on these species and this designated critical habitat (Table 7). The nearest critical habitat for the Mexico and WNP DPS humpback whale is over 200 km from the action area, as is the nearest critical habitat for the Steller sea lion.

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

Species	Status	Listing	Critical Habitat
Cook Inlet beluga whale (*Delphinapterus leucas*)	Endangered	NMFS 2008, 73 FR 62919	NMFS 2011, 76 FR 20180
Humpback Whale, Mexico DPS *(Megaptera novaeangliae)*	Threatened	NMFS 2016, 81 FR 62260	NMFS 2021 86 FR 21082
Humpback Whale, Western North Pacific DPS *(Megaptera novaeangliae)*	Endangered	NMFS 2016, 81 FR 62260	NMFS 2021 86 FR 21082
Steller Sea Lion, Western DPS *(Eumetopias jubatus)*	Endangered	NMFS 1997, 62 FR 24345	NMFS 1993, 58 FR 45269

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

NMFS uses two criteria to identify those endangered or threatened species or critical habitat that are likely to be adversely affected by the proposed action. The first criterion is exposure or some reasonable expectation of a co-occurrence between one or more potential stressors associated with the proposed action and a listed species or designated critical habitat. The second criterion is an assessment of the potential response given exposure. We applied these criteria to the species and critical habitats listed above and determined that critical habitat for Steller sea lions and both DPSs of humpback whale will not be exposed to any of the stressors associated with the proposed project because each are located over 200 km away from the action area. Cook Inlet beluga whale critical habitat will be exposed to stressors from the proposed project but is not likely to be adversely affected.

On April 11, 2011, NMFS published a final rule to designate critical habitat for the Cook Inlet beluga whale (Figure 8; 76 FR 20180). Critical habitat is defined by two areas that together encompass 7,800 km^2 (3,013 mi^2) of marine and estuarine habitat in Cook Inlet. For national security reasons, critical habitat excludes all property and waters of Joint Base Elmendorf-Richardson (JBER) and waters adjacent to the POA.

Critical habitat Area 1 encompasses 1,909 km^2 (738 mi^2) of Cook Inlet northeast of a line from the mouth of Threemile Creek to Point Possession. This area is bounded by the Municipality of Anchorage, the Matanuska-Susitna Borough, and the Kenai Peninsula borough. The area contains shallow tidal flats and river mouths or estuarine areas, and it is important foraging and calving habitat. Mudflats and shallow areas adjacent to medium and high flow accumulation streams may also provide for other biological needs, such as molting or escape from predators (Shelden et al. 2003). Area 1 has the highest concentrations of beluga whales from spring through fall, as well as the greatest potential for adverse impact from anthropogenic threats (76 FR 20180).

Critical habitat Area 2 is located south of Area 1, and includes both near and offshore areas of the mid and upper Inlet, and nearshore areas along the west side and Kachemak Bay on the east side of the lower Inlet. Area 2 consists of 5,891 km^2 (2,275 mi^2) of less concentrated spring and summer beluga whale use, but known fall and winter use areas. It is largely based on dispersed fall and winter feeding and transit areas in waters where whales typically occur in smaller densities or deeper waters (76 FR 20180).

The Cook Inlet Beluga Whale Critical Habitat Final Rule included designation of five Primary Constituent Elements (PCEs), referred to as Physical and Biological Features (PBFs) in this opinion. The below five PBFs were deemed essential to the conservation of the Cook Inlet beluga whale (50 CFR § 226.220(c)):

1. Intertidal and subtidal waters of Cook Inlet with depths <30 feet (MLLW) and within five miles of high and medium flow anadromous fish streams.
2. Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.
3. Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.
4. Unrestricted passage within or between the critical habitat areas.
5. Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.

Portions of critical habitat Area 1 exist within the action area. Knik Arm is used intensively by beluga whales from spring through fall for foraging and as nursery habitat. Foraging primarily occurs at river mouths (e.g., Susitna Delta, Eagle River flats), which are unlikely to be influenced by pile driving activities. The Susitna Delta is more than 20 km from the POA and the land structure at Cairn Point is likely to impede any pile driving noise from propagating into the Eagle River flats in northern Knik Arm.

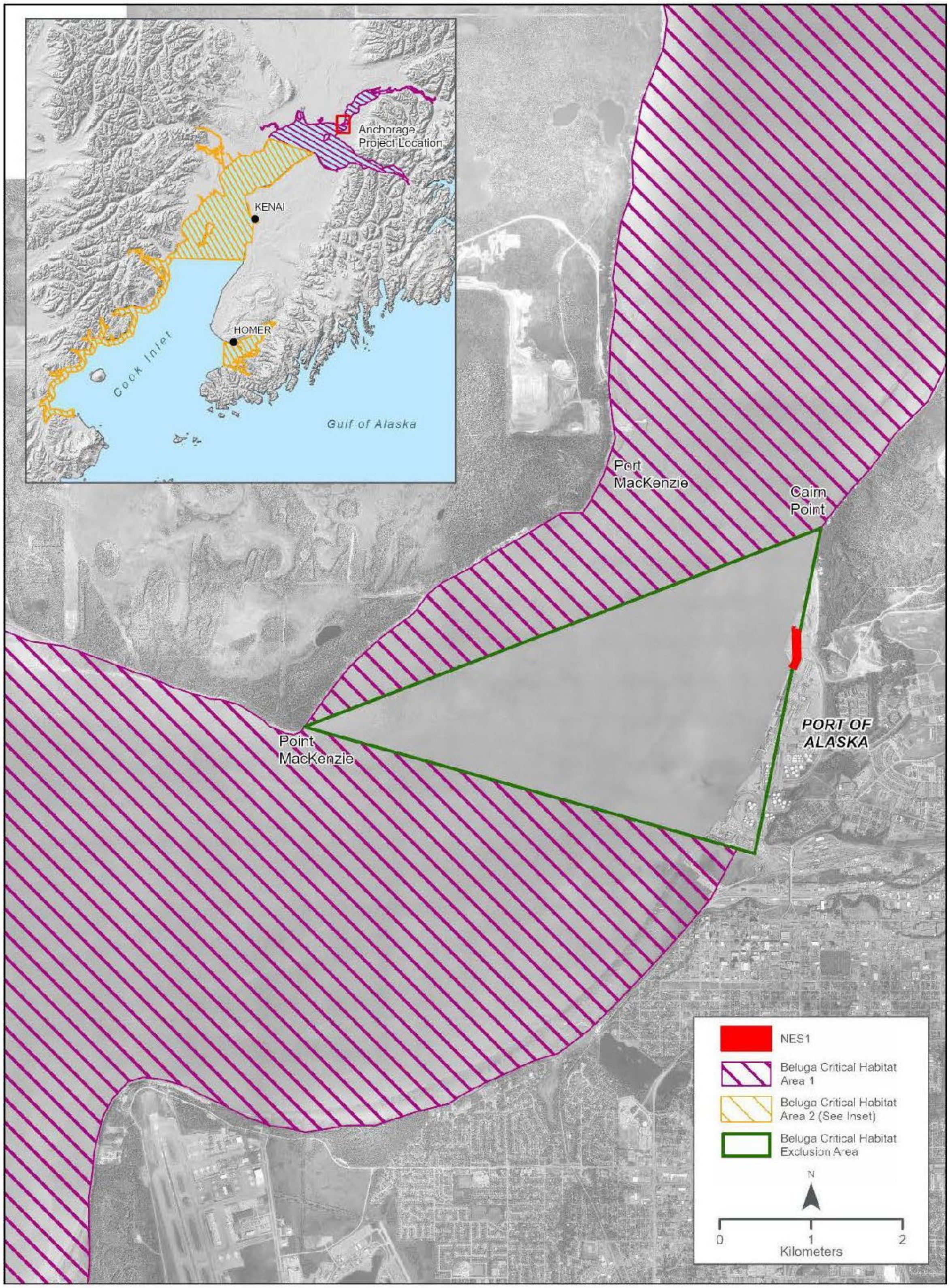

Figure 8. Designated Cook Inlet beluga critical habitat near the NES1 project site.

NMFS has identified noise from project activities, disturbance to the seafloor, turbidity, and the possible accidental release of pollutants as the stressors that may affect Cook Inlet beluga whale critical habitat. The potential effects of these stressors on the PBFs are discussed below.

PBF1: Intertidal and subtidal waters of Cook Inlet with depths <30 feet (MLLW) and within five miles of high and medium flow anadromous fish streams.

The shallow water channels and mudflats at the mouths of anadromous streams are important to belugas because they concentrate prey into narrow channels and offer protection from killer whales. There are several anadromous streams and associated intertidal and subtidal waters that occur within the action area. However, project activities are not expected to affect the bathymetry or hydrology of the anadromous streams or their channels, and their function in concentrating prey or providing protection from killer whales will not be altered. We expect the proposed project to have no effect on PBF1.

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

The action area is located within designated essential fish habitat (EFH) for chum, coho, Chinook, sockeye, and pink salmon. Other managed groundfish species, such as Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole, may occur within the area during early life stages. Increased turbidity, elevation in noise levels during pile driving, and small spills have the potential to impact PBF2.

Project activities may temporarily increase turbidity in the action area. Pile driving may cause temporary and localized turbidity through sediment disturbance; turbidity associated with pile installation is localized to an approximate 7.6 m radius around the pile (Everitt, Fiscus and DeLong 1980). Additionally, approximately 1.35 million cubic yards of fill material dredged from the NES1 sheet pile structure will be disposed offshore in the Anchorage Harbor Open Water Disposal Site. The disposal area is located within the exclusion area of designated Cook Inlet beluga whale critical habitat, and approximately 75 to 90 percent of the dredged material in each load is expected make it to the seafloor within the disposal area (McPherson and Beebee 2023). Nearly all of the fine sediment (smaller than about 0.2 millimeter [mm]), however, is expected to be carried out of the disposal area and into critical habitat by the tide. Fine sediment will remain suspended for 18 minutes to 3 hours after disposal and travel between approximately 2,000 m and 20 km before settling, depending on the tide (McPherson and Beebee 2023). Estuarine deposits underlie the fill material and are mostly composed of fine sediment.

Sediment loads in Cook Inlet are naturally high. The majority of freshwater discharged into Cook Inlet originates from three glacially-fed rivers, which introduce large quantities of sediment into the system. Disposal of fill material will be intermittent, with a period of hours or days between disposal events, and the POA plans to complete in-water work as early in the construction season as possible when beluga presence in the area is typically lower. Only a limited amount of fine sediment is expected to travel into Cook Inlet beluga critical habitat and tidal exchanges will rapidly disperse any localized increase in suspended sediments. The POA is also required to comply with state water quality standards during construction. Therefore, any increases in turbidity are expected to be temporary, localized, and have no measurable impacts to prey species.

Construction activities will produce non-impulsive and impulsive sounds. Fish react to intermittent low-frequency sounds and sounds that are especially strong. It is likely that fish will avoid sound sources within ranges that may be harmful (McCauley, Fewtrell and Popper 2003). The most likely impact to fish from pile driving activities would be temporary behavioral avoidance of the project area. The duration of fish avoidance is unknown, but a rapid return to normal recruitment, distribution, and behavior is expected. The impact of noise on beluga prey is expected to be localized, temporary, and very minor, and adverse effects to PBF2 will be immeasurably small.

Small, unauthorized spills have the potential to affect prey species, including adult anadromous fishes and out-migrating smolts. Small spills are expected to rapidly disperse due to tide-induced turbulence and mixing, and changes in primary prey population levels, distribution, or availability to belugas are not expected. Based on the localized nature of small spills, the relatively rapid weathering and dispersion, and the safeguards in place to avoid and minimize spills, adverse effects to PBF2 prey species are expected to be immeasurably small.

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

No aspect of the proposed project is expected to purposefully or knowingly introduce toxins or harmful agents into the waters of Cook Inlet. Authorized discharges of pollutants are regulated through NPDES permits, which undergo separate ESA section 7 consultations (NMFS 2010b). As discussed in PBF 2, an accidental small spill could occur. Unauthorized small spills are expected to rapidly disperse due to tide-induced currents, turbulence, and mixing. Based on the localized nature of small spills, the relatively rapid weathering and dispersion, and the safeguards in place to avoid and minimize spills, adverse effects to PBF3 are extremely unlikely to occur.

The disposal of fill material dredged from the NES1 sheet pile structure has the potential to release pollutants into the water column either from the disposal of contaminated fill or the resuspension of contaminants caused by disturbance to the existing marine sediments at the disposal site. Fill material will be tested for contaminants (e.g., trace metals, per- and polyfluorinated alkyl substances) and must measure below the regulatory threshold prior to disposal. If contaminated soil is encountered, it will be left in place, treated, and properly disposed of in uplands or hauled to an approved facility for disposal. Disposal of dredged material occurs frequently at the Anchorage Harbor Open Water Disposal Site, and it is unlikely that the disposal of fill from this project will have a negative impact on marine species. Additionally, potential contaminants resuspended from existing marine sediments are expected to return to background levels within 18 minutes to 3 hours. Impacts related to the resuspension of contaminants from fill disposal are expected to be intermittent and brief, and testing prior to disposal will prevent contaminated fill from being dumped at the disposal site. For these reasons, adverse effects to PBF3 are extremely unlikely to occur.

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

Cook Inlet beluga whales are unlikely to be physically restricted from passing through critical habitat; however, noise from pile driving and vessel presence could cause belugas to avoid certain areas while activities are occurring. Avoidance of project-related ensonified areas has the potential to restrict beluga passage between lower and upper Knik Arm. Belugas were observed swimming past the POA during previous construction and dredging activities (Kendall, Sirovic and Roth 2014, Kendall and Cornick 2015, POA 2019, USACE 2019), and we expect belugas to continue unimpeded during the proposed action. Mitigation measures are also expected to allow for unrestricted passage through the action area; pile driving will shut down when belugas are observed approaching the Level B harassment zone and will not resume until the whales have cleared the zone. Based on previous beluga behavior and the implementation of mitigation measures, any effects on passage will likely be too small to detect or measure.

PBF5: Waters with in-water noise below levels resulting in abandonment of critical habitat areas by Cook Inlet Belugas.

Marine mammals have been observed to abandon habitat during periods of construction noise (Wartzok et al. 2003, Forney et al. 2017). Cook Inlet beluga presence in the area has persisted during numerous periods of pile driving, dredging, and other construction activities at the POA. In order to minimize the amount of work occurring during months with high beluga presence, the POA plans to start and complete in-water work as early in the construction season as possible. Additionally, the implementation of mitigation measures will reduce the impact of in-water noise and the likelihood of temporary avoidance by belugas of the POA area. We expect the effects on PBF5 will be immeasurably small.

In summary, activities associated with the proposed NES1 project are not likely to have an adverse effect on Cook Inlet beluga whale critical habitat. Beluga whales may choose not to forage in close proximity to the NES1 site during project activities; however, the POA is not an important foraging location and is excluded from critical habitat. Project stressors will have no effect on PBF 1 and immeasurably small effects on PBFs 2, 3, 4, and 5.

Effects of the project on Cook Inlet beluga whale critical habitat, Steller sea lion critical habitat, Mexico DPS humpback whale critical habitat, and WNP DPS humpback whale critical habitat will not be discussed further.

4.2 Climate Change

One threat common to all the species we discuss in this opinion is global climate change. Because of this commonality, we present an overview here rather than in each of the species-specific narratives. A vast amount of literature is available on climate change and for more detailed information we refer the reader to these websites, which provide the latest data and links to the current state of knowledge on the topic.

https://www.ipcc.ch/reports/

https://climate.nasa.gov/evidence/

http://nsidc.org/arcticseaicenews/

https://arctic.noaa.gov/Report-Card

Increased air temperatures, increased ocean temperatures, and ocean acidification are the three facets of climate change presented here as they have the most direct impact on marine mammals and their prey.

Air temperature

Recording of global temperatures began in 1880, and the last nine years (2014–2022) have ranked as the nine warmest years on record. The yearly temperature for North America has increased at an average rate of 0.23°F since 1910; however, the average rate of increase has doubled since 1981 (0.49°F).[2]

The Arctic (latitudes between 60ºN and 90ºN) has been warming at more than two times the rate of lower latitudes since 2000. This is due to "Arctic amplification", a characteristic of the global climate system influenced by changes in sea ice extent, albedo, atmospheric and oceanic heat transports, cloud cover, black carbon, and many other factors (Serreze and Barry 2011, Richter-Menge et al. 2017, Richter-Menge 2019). The average annual temperature is now 3-4°F warmer than during the early and mid-century (Figure 9). The average annual temperature for Alaska in 2022 was 28.6°F, 2.6°F above the long-term average, ranking the 16th warmest year in the 98-year record for the state.[3] Some of the most pronounced effects of climate change in Alaska include disappearing sea ice, shrinking glaciers, thawing permafrost, and changing ocean temperatures and chemistry (Chapin et al. 2014).

[2] https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202213 accessed July 2023.
[3] https://www.ncei.noaa.gov/access/monitoring/monthly-report/national/202213 accessed July 2023.

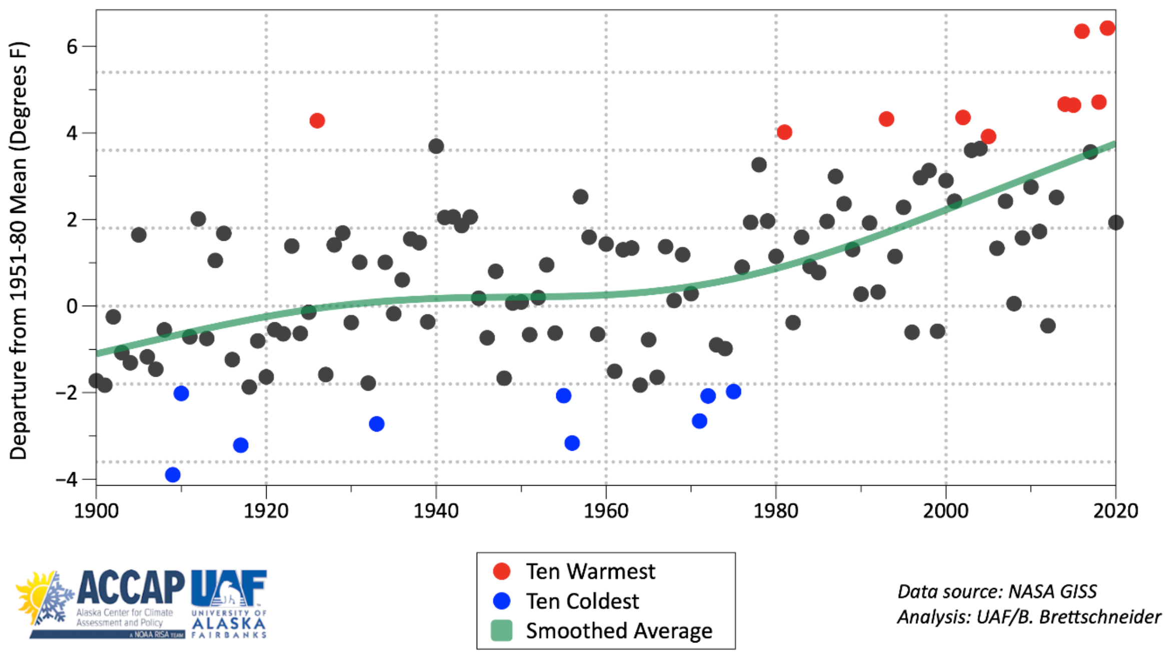

Figure 9. Alaska annual temperature 1900 to 2020.[4]

Marine water temperature

Higher air temperatures have led to higher ocean temperatures. More than 90 percent of the excess heat created by global climate change is stored in the world's oceans, causing increases in ocean temperature (IPCC 2019, Cheng et al. 2020). The four highest annual global ocean heat content (OHC) measurements, which is the amount of heat stored in the upper 2,000 m (6,561 ft) of the ocean, have all occurred in the last four years (2019–2022), and regions of the North Pacific, North Atlantic, and Southern oceans, as well as the Mediterranean Sea, recorded their highest OHC since the 1950s.[5]

The seas surrounding Alaska have been unusually warm in recent years, with unprecedented warmth in some cases (Thoman and Walsh 2019). This effect is observed throughout the Alaska region, including the Bering, Chukchi, and Beaufort seas (Figure 10). Warmer ocean water affects sea ice formation and melt. In the first decade of the 21st century, Arctic sea ice thickness and annual minimum sea ice extent began declining at an accelerated rate and continues to decline at a rate of approximately 2.7 percent per decade (Stroeve et al. 2007, Stroeve and Notz 2018).

Seasonal ice cover in Cook Inlet has not been characterized in as much detail as the Arctic, but the same general trend of later ice formation and earlier melt is expected. Of the three species considered in this opinion, beluga whales are likely the most affected by changing ice conditions in Cook Inlet, as their entire life is spent in this single body of water.

[4] https://www.flickr.com/photos/iarcgroup/albums/72157709844958631 accessed July 2023.
[5] https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202213 accessed July 2023.

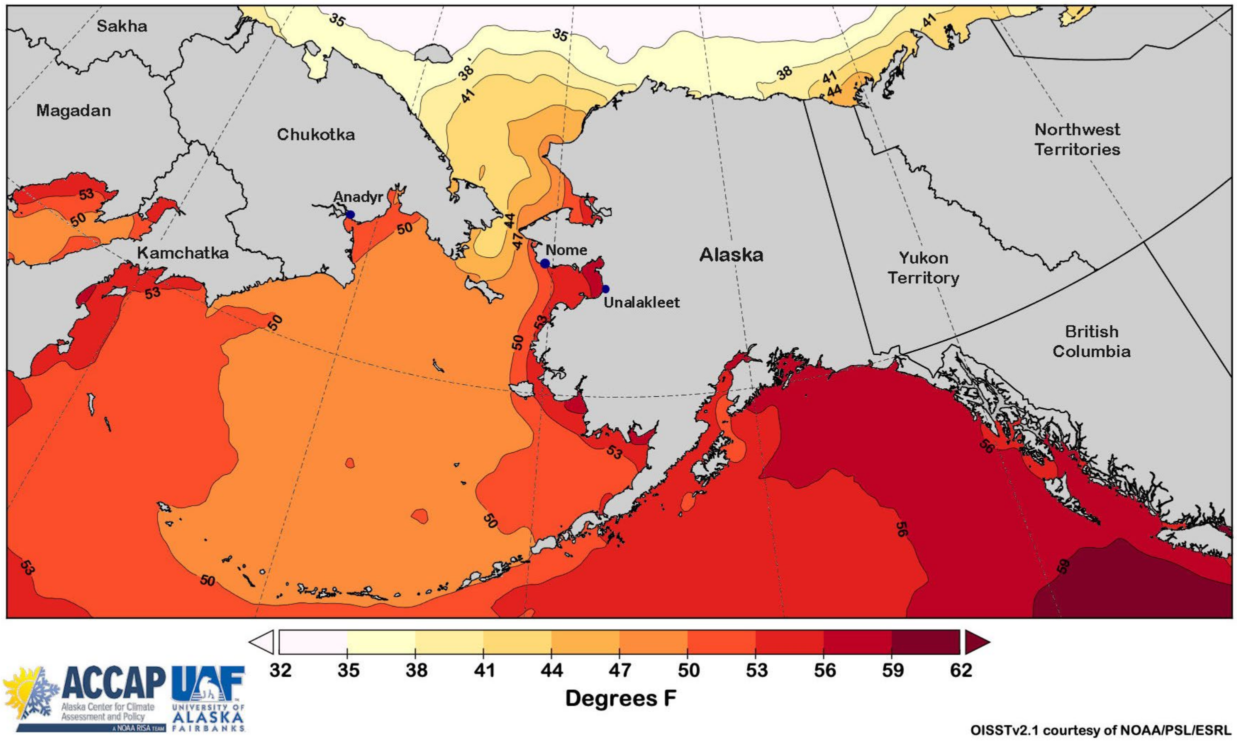

Figure 10. Highest average sea surface temperature 1991-2020.[6]

With the reduction in the cold-water pool in the northern Bering Sea, large scale northward movements of commercial fish stocks are underway, as previously cold-dominated ecosystems warm and fish move northward to higher latitudes (Grebmeier et al. 2006, Eisner et al. 2020). Not only fish, but plankton, crabs, and sessile invertebrates like clams are affected by these changes in water temperature (Grebmeier et al. 2006, Fedewa et al. 2020).

The marine heat wave, a coherent area of extreme warm temperature at the sea surface that persists, is another ocean water anomaly (Frölicher, Fischer and Gruber 2018). Marine heatwaves are a key ecosystem driver and nearly 70 percent of global oceans experienced strong or severe heatwaves in 2016, compared to 30 percent in 2012 (Suryan et al. 2021). The largest recorded marine heat wave occurred in the northeast Pacific Ocean, appearing off the coast of Alaska in the winter of 2013-2014 and extending south to Baja California by the end of 2015 (Frölicher, Fischer and Gruber 2018). The Pacific marine heatwave began to dissipate in mid-2016, but warming re-intensified in late-2018 and persisted into fall 2019 (Suryan et al. 2021). Consequences of this event included an unprecedented harmful algal bloom that extended from the Aleutian Islands to southern California, mass strandings of marine mammals, shifts in the distribution of invertebrates and fish, and shifts in abundance of several fish species (Cavole et al. 2016). Cetaceans, forage fish such as capelin and herring, Steller sea lions, adult cod, chinook and sockeye salmon in the Gulf of Alaska were all impacted by the Pacific marine heatwave (Bond et al. 2015, Peterson, Bond and Robert 2016, Sweeney, Towell and Gelatt 2018).

[6] https://www.flickr.com/photos/iarcgroup/51316771182/in/album-72157709845937092/ accessed July 2023.

The 2018 Pacific cod stock assessment estimated that the female spawning biomass of Pacific cod (an important prey species for Steller sea lions) was at its lowest point in the 41-year time series, following three years of poor recruitment and increased natural mortality as a result of the Pacific marine heatwave.[7] The spawning stock biomass dropped below 20 percent of the unfished spawning biomass in 2020; 20 percent is a minimum spawning stock size threshold instituted to help ensure adequate prey availability for the endangered Western DPS of Steller sea lions. The federal Pacific cod fishery in the Gulf of Alaska was closed by regulation to directed Pacific cod fishing in 2020 as a result (Barbeaux, Holsman and Zador 2020). As of late 2022, Pacific cod had not recovered from the decline during the 2014-2016 marine heatwave.[8]

Ocean Acidification

For 650,000 years or more, the average global atmospheric carbon dioxide (CO2) concentration varied between 180 and 300 parts per million (ppm). Since the beginning of the industrial revolution in the late 1700s, atmospheric CO2 concentrations have been increasing rapidly, primarily due to anthropogenic inputs (Fabry et al. 2008, Lüthi et al. 2008). The world's oceans have absorbed approximately one-third of the anthropogenic CO2 released, which has buffered the increase in atmospheric CO2 concentrations (Feely et al. 2004, Feely, Doney and Cooley 2009). Despite the ocean's role as a large carbon sink, the CO2 level continues to rise and is currently at 419 ppm.[9]

As the oceans absorb CO2, the buffering capacity and pH of seawater is reduced. This process is referred to as ocean acidification. Ocean acidification reduces the saturation states of certain biologically important calcium carbonate minerals like aragonite and calcite that many organisms use to form and maintain shells (Bates, Mathis and Cooper 2009, Reisdorph and Mathis 2014). When seawater is supersaturated with these minerals, calcification (growth) of shells is favored. Likewise, when the seawater becomes undersaturated, dissolution is favored (Feely, Doney and Cooley 2009).

High latitude oceans have naturally lower saturation states of calcium carbonate minerals than more temperate or tropical waters, making Alaska's oceans more susceptible to the effects of ocean acidification (Fabry et al. 2009, Jiang et al. 2015). Model projections indicate that aragonite undersaturation would start to occur by about 2020 in the Arctic Ocean and by 2050, all of the Arctic will be undersaturated with this mineral (Feely, Doney and Cooley 2009, Qi et al. 2017). Large inputs of low-alkalinity freshwater from glacial runoff and melting sea ice contribute to the problem by reducing the buffering capacity of seawater to changes in pH (Reisdorph and Mathis 2014). As a result, seasonal undersaturation of aragonite was already detected in the Bering Sea at sampling stations near the outflows of the Yukon and Kuskokwim Rivers, and the Chukchi Sea (Fabry et al. 2009). Models and observations indicate that rapid sea ice loss will increase the uptake of CO2 and exacerbate the problem of aragonite undersaturation

[7] https://www.fisheries.noaa.gov/alaska/population-assessments/2018-north-pacific-groundfish-stock-assessments accessed July 2023.
[8] https://apps-afsc.fisheries.noaa.gov/REFM/docs/2022/GOA-ESR-Brief.pdf accessed July 2023.
[9] https://gml.noaa.gov/ccgg/trends/ accessed July 2023.

in the Arctic (Yamamoto et al. 2012, DeGrandpre et al. 2020).

Undersaturated waters are potentially highly corrosive to any calcifying organism, such as corals, bivalves, crustaceans, echinoderms and many forms of zooplankton, and, consequently, may affect Arctic food webs (Fabry et al. 2008, Bates, Mathis and Cooper 2009). Pteropods, which are often considered indicator species for ecosystem health, are prey for many species of carnivorous zooplankton, fishes including salmon, mackerel, herring, and cod, and baleen whales (Orr et al. 2005). With their thin shells and dependence on aragonite, pteropods may not be able to grow and maintain shells under increasingly acidic conditions (Lischka and Riebesell 2012). It is uncertain if these species, which play a large role in supporting many levels of the Alaskan marine food web, will be able to adapt to changing ocean conditions (Fabry et al. 2008, Lischka and Riebesell 2012).

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 (Hinzman et al. 2005, Burek, Gulland and O'Hara 2008, Doney et al. 2012, Huntington et al. 2020). The physical effects on the environment described above have impacted, are impacting, and will continue to impact marine species in a variety of ways (IPCC 2014), including shifting abundances, changes in distribution, changes in timing of migration, and changes in periodic life cycles of species. For example, cetaceans with restricted distributions linked to water temperature may be particularly susceptible 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).

4.3 Status of Listed Species and Critical Habitat Likely to be Adversely Affected by the Action

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

For each species, we present a summary of information on the population structure and distribution of the species to provide a foundation for the exposure analyses that appear later in this opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether an action's effects are likely to increase the species' probability of becoming extinct.

4.3.1 Cook Inlet DPS Beluga Whale

4.3.1.1 Status and Population Structure

Beluga whales inhabiting Cook Inlet are one of five distinct stocks found in Alaska (Muto et al. 2022). The best historical abundance estimate of the Cook Inlet beluga population is 1,293 whales, based on a survey in 1979 (Calkins 1989). NMFS began conducting comprehensive, systematic aerial surveys of the population in 1993. These surveys documented a decline in abundance from 653 whales in 1994 to 347 whales in 1998. In response to this nearly 50 percent decline, NMFS designated the Cook Inlet beluga population as depleted under the MMPA in 2000 (65 FR 34590; May 31, 2000). Abundance data collected between 1999 and 2008 indicated that the population did not increase. On October 22, 2008, NMFS published a final rule to list the Cook Inlet beluga whale as endangered under the ESA (73 FR 62919).

The best current abundance estimate for the Cook Inlet beluga whale population is 331 whales (95 percent probability interval of 290 to 386), and is based on aerial surveys conducted in June 2022 (Goetz et al. 2023). A declining trend of 2.3 percent per year occurred from 2008 to 2018, and a comparison of the population estimate over time is presented in Figure 11 (Shelden and Wade 2019). With the addition of the 2021 and 2022 survey data, the trend in the updated time-series suggests the population is stable and may be slightly increasing (Goetz et al. 2023).

Annual mortality, estimated from stranding deaths relative to the population size, averaged 2.2 percent between 2005 to 2017 (McGuire et al. 2021). This is a minimum estimate due to the challenges associated with detecting stranded animals in Cook Inlet, and the number of dead belugas reported is likely only a subset of the total number of whales that expired. Cook Inlet has over 2,400 km of shoreline (Zimmermann and Prescott 2014), most of which is remote. Additionally, carcasses during the winter are likely missed due to decreased visibility and access; 96 percent of carcasses were reported during the ice-free season (April-October). It is estimated that the mean number of reported beluga carcasses represents less than one third of the total number of dead belugas each year (McGuire et al. 2021).

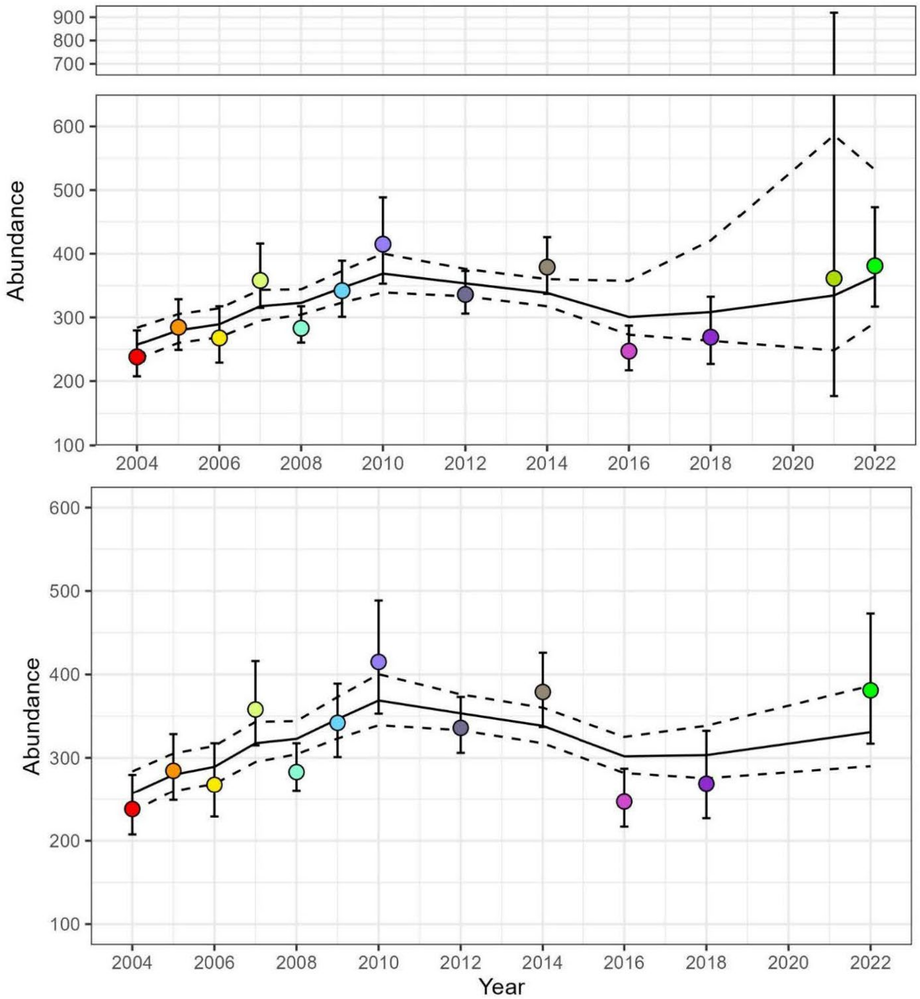

Figure 11. Cook Inlet beluga abundance estimates (circles), moving average (solid line), and 95 percent probability intervals (dotted lines and error bars; Goetz et al. 2023). Top panel includes 2021 survey data.

In the stranding dataset, mortality for Cook Inlet belugas was greatest for adults of reproductive age, followed by calves, with fewer subadults, and no adults older than 49 years (McGuire et al. 2021). Higher mortality of the very old and the very young compared to other age groups is typical in healthy mammal populations, and the mortality rates documented for Cook Inlet belugas are unusual (McGuire et al. 2021). Cook Inlet beluga whales are dying of as-yet unknown causes at relatively younger but still reproductive ages, with few surviving to reach their potential lifespan of 70+ years as reported in other beluga populations.

A detailed description of Cook Inlet beluga whale biology, habitat, and extinction risk factors can be found in the final listing rule for the species (73 FR 62919, October 22, 2008), the Conservation Plan (NMFS 2008a), and the Recovery Plan (NMFS 2016b).

Additional information regarding Cook Inlet beluga whales can be found on the NMFS AKR web site at: https://www.fisheries.noaa.gov/species/beluga-whale

4.3.1.2 Distribution

Cook Inlet beluga whales remain in Cook Inlet year-round and have seasonal movement patterns. During the summer and fall, belugas typically occur in shallow coastal waters and are concentrated near the Susitna River mouth, Knik Arm, Turnagain Arm, and Chickaloon Bay (Shelden et al. 2015b, Castellote et al. 2016a). Ice formation in the upper Inlet during the winter may restrict access to nearshore habitat (Ezer et al. 2013), and belugas are more dispersed in deeper waters in the mid-inlet to Kalgin Island, as well as in the shallow waters along the west shore to Kamishak Bay.

Distribution data, including aerial surveys and acoustic monitoring, indicate that the beluga's range in Cook Inlet has contracted markedly (Figure 12; Shelden et al. 2015b, Shelden and Wade 2019). The distributional shift and range contraction coincided with the decline in abundance (Moore et al. 2000, NMFS 2008a, Goetz et al. 2012). Surveys in the 1970s showed belugas dispersing into the lower inlet by mid-summer, and, prior to the 1990s, whales used areas throughout the upper, mid, and lower inlet during the spring, summer, and fall (Huntington 2000, Rugh, Shelden and Mahoney 2000, NMFS 2008a, Rugh, Shelden and Hobbs 2010). Currently, almost the entire population is found only in northern Cook Inlet from late spring into the fall.

The Susitna Delta is a very important area for Cook Inlet beluga whales, particularly in the summer and fall months. Groups of 200 to 300 individuals, including adults, juveniles, and neonates, have been observed in the Susitna River Delta area in recent years (McGuire, Stephens and Bisson 2014). Acoustic recorders at the Little Susitna River detected a peak from late May to early June, and a large peak from July through August (Castellote et al. 2015). At the Beluga River, acoustic recorders detected three peaks of occurrence: mid-February to early April, June to mid-July (the strongest peak), and mid-November and December (Castellote et al. 2016a). The peaks in May and June appear to coincide with eulachon runs (Vincent-Lang and Queral 1984), and the peaks from June and July coincide with salmon runs (particularly silver and chinook salmon; Brenner, Munro and Larsen 2019).

The area around the East Forelands between Nikiski, Kenai, and Kalgin Island appears to provide important habitat in winter, early spring, and fall. Belugas have been observed in and around the Kenai and Kasilof Rivers throughout the summer (Ovitz 2019), and recent spring and fall monitoring efforts indicate beluga presence in the area during these time periods as well.[10] Acoustic detections indicate that belugas may also be present in the Kenai River throughout the winter (Castellote et al. 2016a).

[10] https://akbmp.org/ Accessed July 2023.

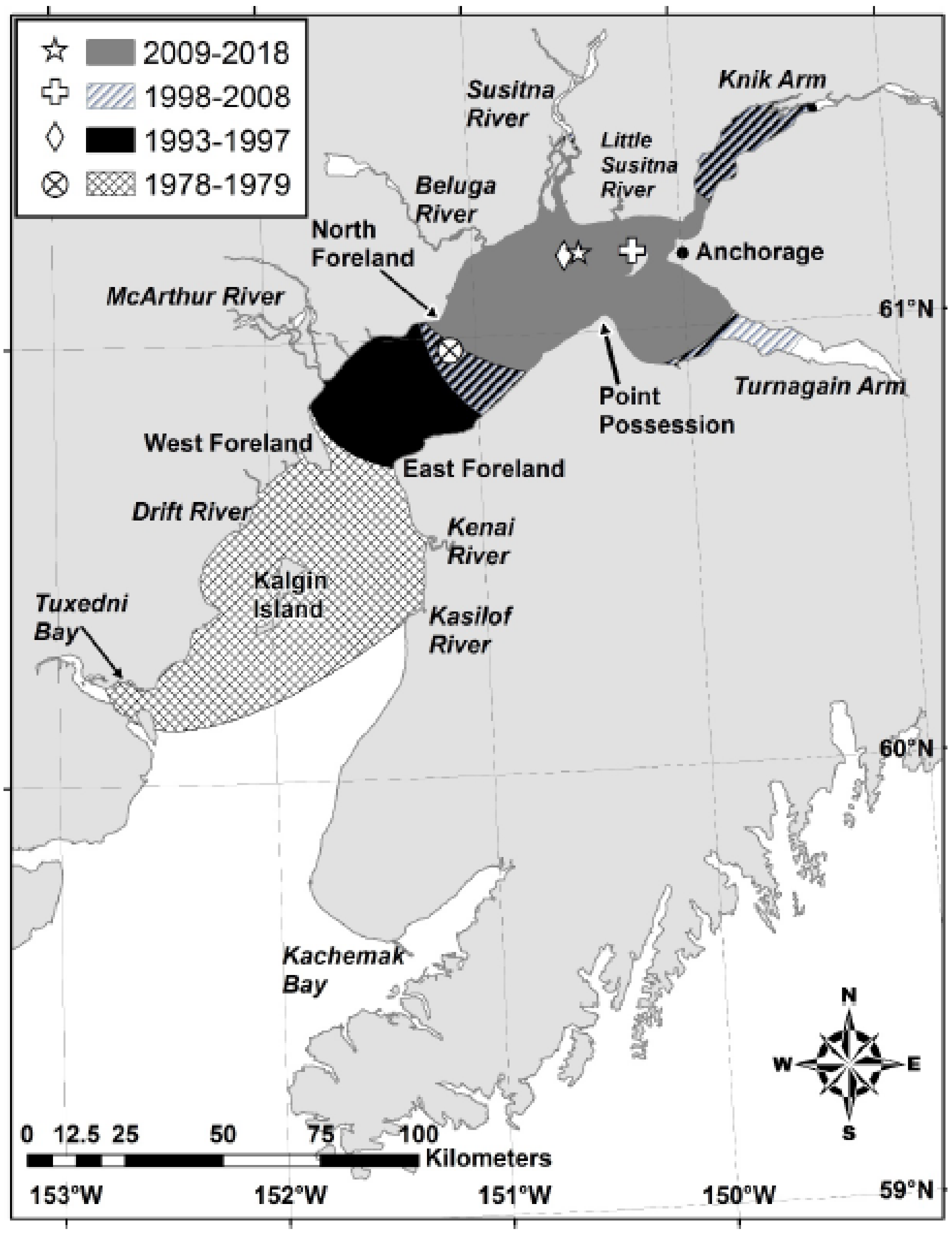

Figure 12. Areas occupied by Cook Inlet beluga whales during systematic aerial surveys.

4.3.1.2.1 Presence in the Action Area

Beluga whales can be found in Knik Arm year-round, but are more frequently observed in the summer and fall. Large concentrations of belugas are present in Knik Arm from August through October (61 North Environmental 2021, 2022a, Easley-Appleyard and Leonard 2022) and their movements in the area are typically characterized by traveling to upper Knik Arm with the high tide and following the low tide back down to Eagle Bay and the POA (McGuire and Stephens 2017). Higher densities north of the POA are expected as belugas tend to concentrate in Eagle Bay to forage, whereas lower Knik Arm is more commonly associated with traveling behavior

(McGuire and Stephens 2017). Traveling was the predominant behavior observed during recent monitoring efforts at the POA; however, belugas were also frequently observed milling in lower Knik Arm, sometimes for hours (61 North Environmental 2021, 2022a, Easley-Appleyard and Leonard 2022). When milling was recorded as one of the behaviors, the sighting duration was more than four hours for approximately nine percent of the beluga sightings (61 North Environmental 2021, 2022a, Easley-Appleyard and Leonard 2022).

Marine mammal monitoring programs have occurred at or in close proximity to the POA, since 2005. Table 8 summarizes beluga whale observations and monitoring effort in the POA area.

Table 8. Beluga observations and monitoring effort in the POA area.

Year	Monitoring Project	Project Dates	Monitoring Effort		Total # of Groups	Total # of Belugas
			# of Days	# of Hours		
2005	MTRP[1]	August 2–Nov. 28	51	374	21	157
2006	MTRP[1]	April 26–Nov. 3	95	564	25	82
2007	MTRP[1]	Oct. 9–Nov. 20	28	139	14	61
2008	MTRP[1]	June 24–Nov. 14	86	612	74	283
	MTRP[2]	July 24–Dec. 2	108	607	59	431
2009	MTRP[1]	May 4–Nov. 18	86	783	54	166
	MTRP[2]	March 28–Dec. 14	214	3,322	NA	1,221
2010	MTRP[1]	June 29–Nov. 19	87	600	42	115
	MTRP[2]	July 21–Nov. 20	106	862	103	731
2011	MTRP[1]	June 28–Nov. 15	104	1,202	62	290
	MTRP[2]	July 17–Sept. 27	16	NA	5	48
2016	Port MacKenzie	April 18–April 30	12	98	12	113
	Test Pile Program	May 3–June 21	19	85.3	9	10
2017	Ship Creek Boat Launch	August 23–September 11	16	41.7	34	153
2018	POA Dredging	April 2–October 31	141	NA	NA	121
2019	PCT Dredging	May 8–September 17	133	NA	66	797
	POA Fender Pile	May 16–October 30	28	NA	1	3
2020	PCT Construction	April 27–November 24	128	1,238.7	245	987
2021	POA Dredging	April 7–October 31	140	NA	NA	1,527
	PCT Construction	April 26–September 29	74	734.9	132	517
	NMFS	July 9–October 17	29	231.6	113	578
2022	PCT/SFD Dredging	May 3–August 24	70	727	90	529
	SFD Construction	May 20–June 11	13	108.2	9	41
	POA Geotechnical Survey	November 18–December 7	7	41.63	1	2

[1] Marine Terminal Redevelopment Project (MTRP) Scientific Monitoring
[2] MTRP Construction Monitoring

The Alaska Beluga Monitoring Program (AKBMP), a citizen science project established in 2019, includes a monitoring location at the Ship Creek small boat launch.[11] During 78 approximately two-hour long monitoring sessions over 69 days between August 15 and November 5, 2019, 75 beluga sightings were recorded. From August 15 to November 14, 2020 (65 sessions on 53 days), there were 95 beluga sightings. Beluga sightings peaked in mid-September both years. AKBMP initiated spring monitoring sessions in 2021, and no belugas were observed between March 18 and May 30 (64 sessions on 50 days) of that year. Fall monitoring sessions resumed August 25 and continued until November 6, 2021 (61 sessions on 49 days); 83 beluga sightings were recorded. From March 12 to May 31, 2022 (37 sessions on 81 days), only one beluga was recorded.

4.3.1.3 Feeding and Prey Selection

Cook Inlet beluga whales have diverse diets (Quakenbush et al. 2015, Nelson et al. 2018), including multiple fish and benthos species, and often forage at river mouths. Primary prey species consist of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole. Belugas seasonally shift their distribution within Cook Inlet in relation to the timing of fish runs and seasonal changes in ice and currents (NMFS 2016b).

The seasonal availability of energy-rich prey is very important to the energetics of belugas (Abookire and Piatt 2005, Litzow et al. 2006). Cook Inlet belugas have much lower fat reserves in the spring than after feeding on abundant eulachon and salmon in the spring and summer (NMFS 2007, Saupe et al. 2014). Eating fatty prey and building up fat reserves in the spring and summer may allow beluga whales to sustain themselves during periods of reduced prey availability in winter or when metabolic needs are higher (NMFS 2007).

4.3.1.4 Reproduction

Probable mating behavior was observed in April and May of 2014 in Trading Bay (Lomac-MacNair et al. 2016). Conception is predicted to peak from March through May, based on analysis of stranded neonates, fetuses, and calves of the year; however, conception can occur over a wide period of up to seven months (Shelden et al. 2020). Neonates have been observed between early July and mid-October (McGuire and Stephens 2017), and the only documented beluga birth occurred on July 20, 2015 in the Susitna River Delta (McGuire and Stephens 2017). Most calving in Cook Inlet is assumed to occur from mid-May to mid-July (Calkins 1989), but calving could occur through the entire ice-free period from April through November (Shelden et al. 2020). Young beluga whales are nursed for two years and may continue to associate with their mothers for a considerable time thereafter (Colbeck et al. 2013).

4.3.1.5 Vocalization, Hearing, and Other Sensory Capabilities

Beluga whales produce sounds for communication and echolocation. Belugas, and other odontocetes, make sounds across some of the widest frequency bands that have been measured in

[11] https://akbmp.org/ Accessed July 2023.

any animal group. For their social interactions, belugas emit communication calls with an average frequency range of about 0.2 to 7.0 kHz (Garland, Castellote and Berchok 2015). Belugas produce a variety of audible whistles, squeals, clucks, mews, chirps, trills, and bell-like tones (Castellote et al. 2014). At the higher-frequency end of their hearing range, belugas use echolocation signals with peak frequencies at 40-120 kHz, which help to navigate and hunt in dark or turbid waters where vision is limited (Au 2000). Beluga whales are one of five non-human mammal species for which there is convincing evidence of frequency modulated vocal learning (Payne and Payne 1985, Tyack 1999, Stoeger et al. 2012).

Even among odontocetes, beluga whales are known to be one of the most adept users of sound. The unfused vertebrae and highly movable head of the beluga whale may have allowed for adaptation of their sophisticated directional hearing. Multiple studies have examined hearing sensitivity of belugas in captivity (Awbrey, Thomas and Kastelein 1988, Johnson, McManus and Skaar 1989, Klishin, Popov and Supin 2000, Ridgway et al. 2001, Finneran et al. 2002a, Finneran et al. 2002b, Finneran et al. 2005, Mooney et al. 2008). In the first report of hearing ranges of belugas in the wild, Castellote et al. (2014) documented a wide range of sensitive hearing from 20-110 kHz, with minimum detection levels around 50 dB. These results were similar to the ranges reported in the captive studies, however, the levels and frequency range of the wild belugas indicate the whales have sensitive hearing compared to previous studies of belugas and other odontocetes (Houser and Finneran 2006, Houser et al. 2018). Most of these studies measured beluga hearing in very quiet conditions. Tidal currents in Cook Inlet regularly produce ambient sound levels well above 100 dB (Lammers et al. 2013), and beluga signal intensity can change with location and background noise levels (Au et al. 1985).

4.3.1.6 Threats

The Cook Inlet Beluga Recovery Plan (NMFS 2016b) addresses ten principal threats to the population. Table 9 provides a summary of these threats and their potential impact on Cook Inlet beluga recovery.

Table 9. Cook Inlet beluga whale recovery plan ten principal threats summary.

Threat Type	ESA § 4(a)(1) factor	Major effect	Extent	Frequency	Trend	Probability	Magnitude	Relative concern
Catastrophic events (e.g., natural disasters; spills; mass strandings)	A, D, E	Mortality, compromised health, reduced fitness, reduced carrying capacity	Localized	Intermittent and Seasonal	Stable	Medium to High	Variable Potentially High	High
Cumulative effects	C, D, E	Chronic stress; reduced resilience	Range wide	Continuous	Increasing	High	Unknown Potentially High	High
Noise	A, D, E	Compromised communication & echolocation, physiological damage, habitat degradation	Localized & Range wide	Continuous, Intermittent, and Seasonal	Increasing	High	Unknown Potentially High	High
Disease agents (e.g., pathogens; parasites; harmful algal blooms)	C	Compromised health, reduced reproduction	Range wide	Intermittent	Unknown	Medium to High	Variable	Medium
Habitat loss or degradation	A	Reduced carrying capacity, reduced reproduction	Localized & Range wide	Continuous and Seasonal	Increasing	High	Medium	Medium
Reduction in prey	A, D, E	Reduced fitness (reproduction and/or survival); reduced carrying capacity	Localized & Range wide	Continuous, Intermittent, and Seasonal	Unknown	Unknown	Unknown	Medium
Unauthorized take	A, E	Behavior modification, displacement, injury or mortality	Range wide, localized hotspots	Seasonal	Unknown	Medium	Variable	Medium
Pollution	A	Compromised health	Localized & Range wide	Continuous, Intermittent, and Seasonal	Increasing	High	Low	Low
Predation	C	Injury or mortality	Range wide	Intermittent	Stable	Medium	Low	Low
Subsistence hunting	B, D	Injury or mortality	Localized	Intermittent	Stable or Decreasing	Low	Low	Low

4.3.2 Mexico and Western North Pacific DPS Humpback Whales

4.3.2.1 Population Structure and Status

Humpback whales are found in all oceans of the world with a broad geographical range from tropical to temperate waters in the Northern Hemisphere and from tropical to near-ice-edge waters in the Southern Hemisphere. Additional information on humpback whale biology and natural history is available at: https://www.fisheries.noaa.gov/species/humpback-whale

In 1970, the humpback whale was listed under the Endangered Species Conservation Act (ESCA) as endangered worldwide (35 FR 18319; December 2, 1970), primarily due to overharvest by commercial whaling. Congress replaced the ESCA with the ESA in 1973 and humpback whales continued to be listed as endangered. Humpback whales are also considered "depleted" under the MMPA. Following the cessation of commercial whaling, humpback whale numbers increased.

NMFS conducted a global status review of humpback whales (Bettridge et al. 2015) and published a final rule recognizing 14 DPSs on September 8, 2016 (81 FR 62260). Four of these DPSs were designated as endangered and one as threatened, with the remaining nine not warranting ESA listing status.

Based on an analysis of migration between winter mating/calving areas and summer feeding areas using photo-identification, Wade (2021) concluded that humpbacks feeding in Alaskan waters belong primarily to the Hawaii DPS (recovered), with small numbers from the Mexico DPS (threatened) and WNP DPS (endangered). Whales from these three DPSs overlap on feeding grounds off Alaska, and are visually indistinguishable unless individuals have been photo-identified on breeding grounds and again on feeding grounds. All waters off the coast of Alaska may contain ESA-listed humpbacks.

There are approximately 2,913 animals in the Mexico DPS and 1,084 animals in the WNP DPS (Wade 2021). The population trend is unknown for both DPSs. The Hawaii DPS is estimated at 11,540 animals, and the annual growth rate is between 5.5 and 6.0 percent (Wade 2021). Humpbacks in Cook Inlet, which is considered part of their Gulf of Alaska summer feeding area, are comprised of approximately 89 percent Hawaii DPS individuals, 11 percent Mexico DPS individuals, and less than 1 percent WNP DPS individuals.

4.3.2.2 Distribution

Humpback whales generally undertake seasonal migrations from their tropical calving and breeding grounds in winter to their high-latitude feeding grounds in summer, although some individuals may remain in Alaska waters year-round. Most humpbacks that summer in Alaska winter in temperate or tropical waters near Mexico, Hawaii, or in the western Pacific near Japan. In the spring, those animals migrate back to Alaska, where food is abundant. They tend to concentrate in several areas, including Southeast Alaska, Prince William Sound, Kodiak, the Bering Sea, and along the Aleutian Islands (Wild et al. 2023). Large numbers of humpbacks have also been reported in waters over the continental shelf, extending up to 185 km offshore in the western Gulf of Alaska (Wade 2021).

4.3.2.2.1 Presence in Cook Inlet

Humpback whales have been observed throughout Cook Inlet, but are primarily found in the lower inlet. The NMFS aerial surveys for Cook Inlet belugas recorded 88 sightings of 192 humpbacks between 1993 and 2016; all were located in lower Cook Inlet (Rugh, Shelden and Mahoney 2000, Rugh et al. 2005, Shelden et al. 2013, Shelden et al. 2015a, Shelden et al. 2017).

Two humpbacks were observed north of the Forelands during marine mammal monitoring in May and June of 2015 (Jacobs Engineering Group 2017). Marine mammal monitoring near the mouth of Ship Creek also recorded two humpback whale sightings, likely of the same individual, in September 2017 (ABR 2017). Three humpback whales were recorded near Ladd Landing, north of the Forelands, in 2018 during marine mammal monitoring (Sitkiewicz et al. 2018). One humpback was observed in July 2022 during transitional dredging at the POA (61 North Environmental 2022b). Deceased humpbacks were reported in upper Cook Inlet in 2015, 2017, and 2019. Sightings of humpback whales in the action area are rare, and few, if any, are expected.

4.3.2.3 Feeding and Prey Selection

Humpback whales exhibit flexible feeding strategies, sometimes foraging alone and sometimes cooperatively (Clapham 1993). Humpback whales are ‘gulp’ or ‘lunge’ feeders, capturing large mouthfuls of prey during feeding rather than continuously filtering food, as may be observed in some other large baleen whales (Goldbogen et al. 2008, Simon, Johnson and Madsen 2012). When lunge feeding, whales advance on prey with their mouths wide open, then close their mouths around the prey and trap them by forcing engulfed water out past the baleen plates. Compared to some other baleen whales, humpbacks are relatively generalized in their prey selection. In the Northern Hemisphere, known prey includes euphausiids (krill), copepods, juvenile salmonids, herring, Arctic cod, walleye pollock, pteropods, and cephalopods (Johnson and Wolman 1984, Perry, DeMaster and Silber 1999, Straley et al. 2018).

In the North Pacific, humpback whales forage in the coastal and inland waters along California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Tomilin 1967, Johnson and Wolman 1984). The waters surrounding Kodiak Island have been identified as a biologically important area for seasonal feeding and are considered active May through September (Wild et al. 2023).

4.3.2.4 Reproduction

Humpbacks in the Northern Hemisphere give birth and presumably mate on low-latitude wintering grounds from January to March. Females attain sexual maturity at five years old in some populations and exhibit a mean calving interval of approximately two years (Clapham 1992, Barlow and Clapham 1997). Gestation is about 12 months, and calves are probably weaned by the end of their first year (Perry, DeMaster and Silber 1999).

4.3.2.5 Vocalization, Hearing, and Other Sensory Capabilities

Mysticetes are likely most sensitive to sound from an estimated tens of hertz to approximately ten kilohertz (Southall et al. 2007). Evidence suggests that humpbacks can hear sounds as low as 7 Hz up to 24 kHz, and possibly as high as 30 kHz (Ketten 1997, Au et al. 2006). NMFS categorizes humpback whales in the low-frequency cetacean functional hearing group, with a generalized hearing range between 7 Hz and 35 kHz (NMFS 2018f). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Humpback whales produce a wide variety of sounds ranging from 20 Hz to 10 kHz, especially animals in mating groups (Tyack 1981, Silber 1986). During the breeding season males sing long, complex songs, with frequencies in the 20-5,000 Hz range and intensities as high as 181 dB (Payne 1970, Winn, Perkins and Poulter 1970, Thompson, Cummings and Ha. 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson, Winn and Perkins. 1979). The songs appear to have an effective range of approximately 10 to 20 km. Social sounds associated with aggressive behavior by male humpback whales in breeding areas are very different than songs and extend from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz (Tyack and Whitehead 1983, Silber 1986). These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983). Humpback whales produce sounds less frequently in their summer feeding areas. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 seconds and source levels of 175-192 dB (Thompson, Cummings and Ha. 1986). These sounds are attractive and appear to rally animals to the feeding activity (D'Vincent, Nilson and Hanna 1985, Sharpe and Dill 1997).

4.3.2.6 Threats

4.3.2.6.1 Natural Threats

There is limited information on natural sources of injury or mortality to humpback whales. Based upon prevalence of tooth marks, attacks by killer whales appear to be highest among humpback whales migrating between Mexico and California, although populations throughout the Pacific Ocean appear to be targeted to some degree (Steiger et al. 2008). Juveniles appear to be the primary age group targeted.

Thirteen marine mammal species in Alaska were examined for domoic acid; humpback whales indicated a 38 percent prevalence (Lefebvre et al. 2016). Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales at 50 percent. The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992).

4.3.2.6.2 Anthropogenic Threats

Historically, commercial whaling represented the greatest threat to every population of humpback whale. In 1963, the International Whaling Commission (IWC) banned commercial hunting of humpback whales in the Pacific Ocean, and, as a result, this threat has largely been curtailed. No commercial whaling occurs within the range of Mexico DPS humpbacks. Japan resumed commercial whaling in its territorial sea and exclusive economic zone, which is within the WNP DPS humpback range, in 2019. Previously, "commercial bycatch whaling" was documented within the WNP DPS humpback range in Japan and South Korea (Bettridge et al. 2015). Alaska Native subsistence hunters are not granted aboriginal subsistence whaling permits under the IWC to take humpback whales.

Vessel strike is one of the main threats and sources of anthropogenic impacts to humpback whales in Alaska. Neilson et al. (2012) summarized 108 ship strike events in Alaska from 1978 to 2011; 86 percent involved humpback whales. Eighteen humpbacks were struck by vessels between 2016 and 2020 (Freed et al. 2022). Most ship strikes of humpback whales are reported in Southeast Alaska (Helker et al. 2019), where high vessel traffic overlaps with whale presence.

Fishing gear entanglement is another major threat. Entanglement may result in only minor injury or may significantly affect individual health, reproduction, or survival. Every year humpback whales are reported entangled in fishing gear in Alaska, particularly pot gear and gill net gear. Between 2016 and 2020, entanglement of humpback whales (n = 47) was the most frequent human-caused source of mortality and injury of large whales in Alaska (Freed et al. 2022).

4.3.3 Steller Sea Lion

4.3.3.1 Population Structure and Status

On November 26, 1990, NMFS published a final rule to list Steller sea lions as threatened (55 FR 49204). In 1997, NMFS reclassified Steller sea lions as two DPSs (62 FR 24345; May 5, 1997); the Eastern DPS was listed as threatened and the Western DPS was listed as endangered. On November 4, 2013, NMFS published a final rule to delist the Eastern DPS (78 FR 66140). Information on Steller sea lion biology and habitat (including critical habitat) is available in the revised Steller Sea Lion Recovery Plan (NMFS 2008b) and 5-year Status Review (NMFS 2020).

The Western DPS of Steller sea lions decreased from an estimated 220,000 to 265,000 animals in the late 1970s to fewer than 50,000 in 2000 (Muto et al. 2021). Factors that may have contributed to this decline include incidental take in fisheries, competition with fisheries for prey, legal and illegal shooting, predation, exposure to contaminants, disease, and ocean regime shift-driven climate change (NMFS 2008b). The most recent comprehensive surveys of Western DPS Steller sea lions estimated a total Alaska population (both pups and non-pups) of 49,320 (Sweeney et al. 2023). Between 2007 and 2022, Western DPS Steller sea lion pups increased by 0.50 percent per year and non-pups increased by 1.05 percent per year (Sweeney et al. 2023). While the data show the overall population trend is positive, abundance and trends are highly variable across regions and age classes.

Pup counts declined in the eastern and central Gulf of Alaska between 2015 and 2017, counter to the increases observed in both regions since 2002 (Sweeney et al. 2017). These declines may have been due to changes in prey availability from the marine heatwave that occurred in the northern Gulf of Alaska from 2014 to 2016 (Bond et al. 2015, Petersen et al. 2016, Muto et al.

2021). Pup counts rebounded to 2015 levels in 2019; however, non-pup counts in the eastern, central, and western Gulf of Alaska regions declined (Muto et al. 2021).

4.3.3.2 Distribution

Steller sea lions range along the North Pacific rim from northern Japan to California, with centers of abundance in the Gulf of Alaska and Aleutian Islands (Figure 14; Loughlin, Rugh and Fiscus 1984). Although Steller sea lions seasonally inhabit coastal waters of Japan in the winter, breeding rookeries outside of the U.S. are only located in Russia (Burkanov and Loughlin 2005). Steller sea lions are not known to migrate annually, but individuals may widely disperse outside of the breeding season (late May to early July; Jemison et al. 2013, Muto et al. 2021).

Land sites used by Steller sea lions are referred to as rookeries and haulouts (Figure 13). Rookeries are used by adult sea lions for pupping, nursing, and mating during the reproductive season. Haulouts are used by all age classes of both sexes but are generally not where sea lions reproduce. At the end of the reproductive season, some females may move with their pups to other haulout sites and males may migrate to distant foraging locations (Spalding 1964, Pitcher and Calkins 1981). Sea lions may make semi-permanent or permanent one-way movements from one site to another (Chumbley et al. 1997, Burkanov and Loughlin 2005). Round trip migrations of greater than 6,500 km by individual Steller sea lions have been documented (Jemison et al. 2013).

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

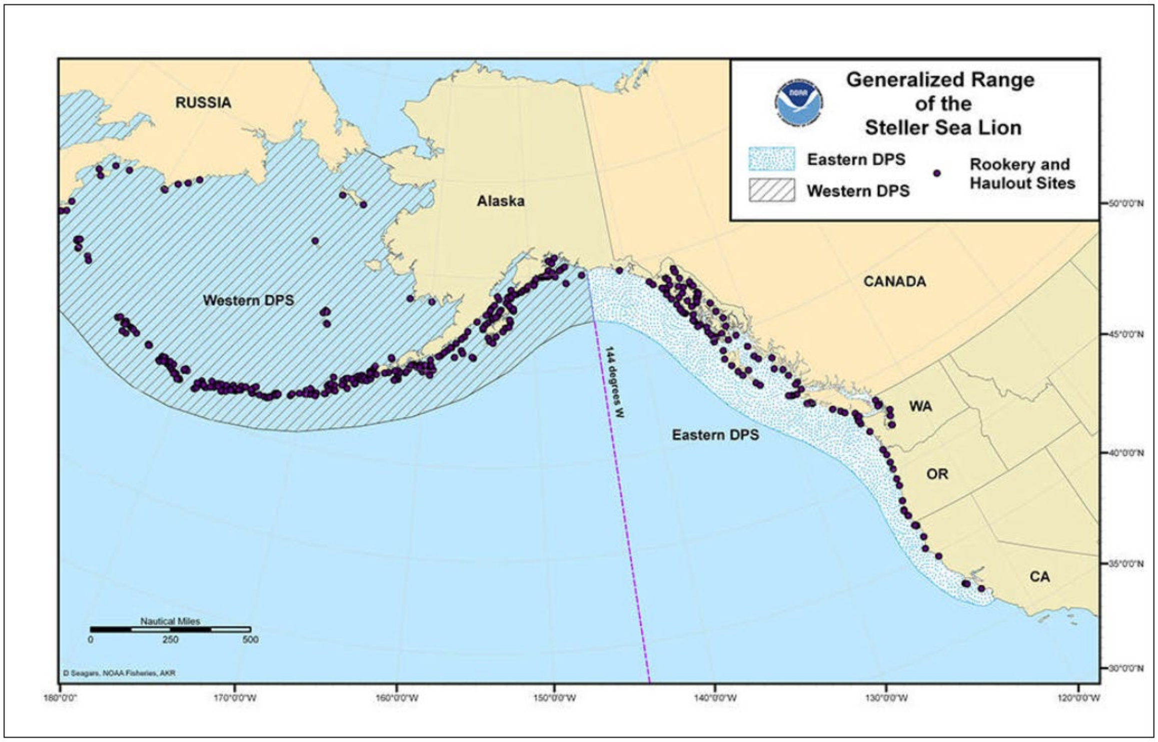

Figure 13. Ranges of Western and Eastern DPS Steller sea lions and rookery and haulout sites.

4.3.3.2.1 Presence in Cook Inlet

Sightings of Steller sea lions in middle and upper Cook Inlet are rare, and density data are not available for this region. The majority of Steller sea lion sightings recorded during NMFS aerial surveys for Cook Inlet belugas were located south of the Forelands (Rugh et al. 2005, Shelden et al. 2013).

POA projects in recent years have recorded several Steller sea lions during monitoring efforts. During Phase 1 PCT construction monitoring from the end of May to the end of June 2020, up to six Steller sea lions were observed; at least two of these observations may have been re-sightings of the same individual, as they occurred on the same day (61 North Environmental 2021). Between the end of May and the end of September 2021, nine Steller sea lions were observed during monitoring associated with Phase 2 PCT construction (61 North Environmental 2022a, Easley-Appleyard and Leonard 2022). An additional seven unidentified pinnipeds were observed in 2020 and another one in 2021, which could have been harbor seals or Steller sea lions (61 North Environmental 2021, 2022a). Three Steller sea lions were observed between mid-May and mid-June 2022 during the South Floating Dock construction monitoring (61 North Environmental 2022c).

About 3,600 Steller sea lions use terrestrial sites in the lower Cook Inlet area (Sweeney et al. 2017), with additional individuals foraging in the area. The nearest major rookery or haulout site to the POA is over 200 km away (Figure 14).

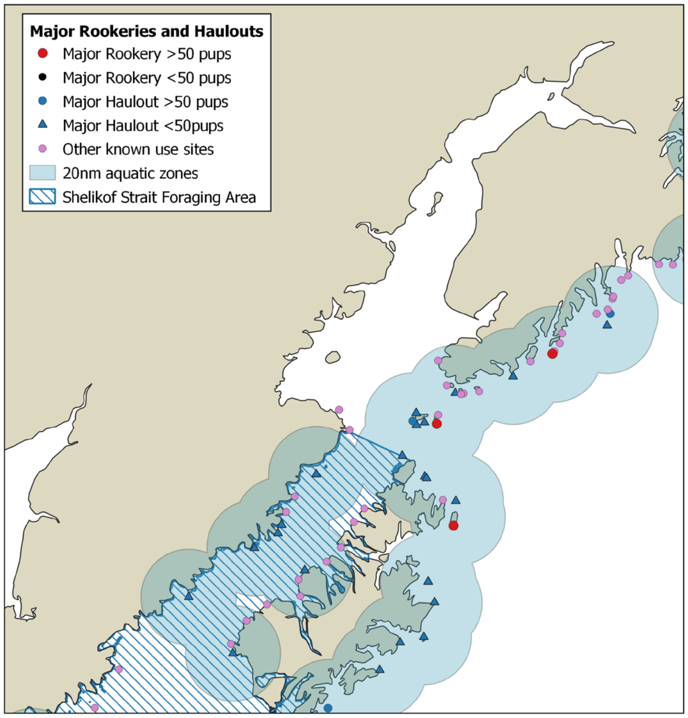

Figure 14. Steller sea lion major rookeries and haulouts in the lower Cook Inlet area.

4.3.3.3 Feeding, Diving, Hauling out, and Social Behavior

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

During summer, Steller sea lions feed mostly over the continental shelf and shelf edge. Females attending pups forage within 37 km of breeding rookeries (Merrick and Loughlin 1997), which is the basis for designated critical habitat around rookeries and major haulout sites. Steller sea lions tend to make shallow dives of less than 250 m but are capable of deeper dives (NMFS 2018f). Female foraging trips during winter tend to be longer in duration, farther from shore, and with deeper dives. Summer foraging dives, on the other hand, tend to be closer to shore and are shallower (Merrick and Loughlin 1997). Adult females begin a regular routine of alternating foraging trips at sea with nursing their pups on land a few days after birth.

Steller sea lions are gregarious animals that often travel in large groups of up to 45 individuals (Keple 2002), and rafts of several hundred animals are often observed adjacent to haulouts. Individual rookeries and haulouts may be comprised of hundreds of animals. At sea, groups usually consist of females and subadult males as adult males are usually solitary (Loughlin 2002).

4.3.3.4 Reproduction

Male Steller sea lions reach sexual maturity between ages three and seven, but do not reach physical maturity and participate in breeding until about eight to ten years of age (Pitcher and Calkins 1981). Female Steller sea lions reach sexual maturity and first breed between three and eight years of age, and the average age of reproductive females is about ten (Pitcher and Calkins 1981, Calkins and Pitcher 1982, York 1994).

After maturity, females normally ovulate and breed annually. There is a high rate of reproductive failure but, when successful, females give birth to a single pup between May and July. The sex ratio of pups at birth is assumed to be about 1:1, or slightly biased toward males. Newborn pups are wholly dependent upon their mother for milk during at least the first three months, and observations suggest they continue to be highly dependent through the first winter (Trites et al. 2006).

4.3.3.5 Vocalization, Hearing, and Other Sensory Capabilities

The ability to detect sound and communicate underwater is important for a variety of Steller sea lion life functions, including reproduction and predator avoidance. NMFS categorizes Steller sea lions in the otariid pinniped functional hearing group, with an applied frequency range between 60 Hz and 39 kHz in water (NMFS 2018f). Studies of Steller sea lion auditory sensitivities have found that this species detects sounds underwater between 1 and 25 kHz (Kastelein et al. 2005), and in air between 250 Hz and 30 kHz (Mulsow and Reichmuth 2010). Sound signals from vessels are typically within the hearing range of Steller sea lions, whether the animals are in the water or hauled out.

4.3.3.6 Threats

4.3.3.6.1 Natural Threats

Killer whale predation on the Western DPS, under reduced population size, may cause significant reductions in the stock (NMFS 2008b). Steller sea lions are also vulnerable to predation from sleeper sharks. Juvenile Steller sea lions were found to underutilize foraging habitats and prey resources based on predation risk by killer whales and sleeper sharks (Frid et al. 2009).

Steller sea lions have tested positive for several pathogens, and parasites are common; however, disease levels and mortality resulting from infestation are unknown. Significant negative effects of these factors may occur in combination with stress, which may compromise the immune system. If other factors, such as disturbance, injury, or difficulty feeding occur, it is more likely that disease and parasitism can play a greater role in population reduction

The female spawning biomass of Pacific cod, an important prey species for Steller sea lions, was at its lowest point in 2018.[12] The federal Pacific cod fishery in the Gulf of Alaska was closed by

[12] https://www.fisheries.noaa.gov/alaska/population-assessments/2018-north-pacific-groundfish-stock-assessments accessed July 2023.

regulation to directed Pacific cod fishing in 2020 (Barbeaux, Holsman and Zador 2020), and the species has yet to recover from the decline that occurred during the 2014-2016 marine heatwave.[13]

4.3.3.6.2 Anthropogenic Threats

Subsistence hunters removed 209 Western DPS Steller sea lions between 2014 and 2018 in controlled and authorized harvests (Muto et al. 2021). Between 2016 and 2020, human-caused mortality and injury of the Western DPS Steller sea lions (n = 148) was primarily caused by entanglement in fishing gear, in particular, commercial trawl gear (n=113; Freed et al. 2022).

Concern also exists regarding competition between commercial fisheries and Steller sea lions for the same resource: stocks of pollock, Pacific cod, and Atka mackerel. Limitations on fishing grounds, duration of fishing season, and monitoring have been established to prevent Steller sea lion nutritional deficiencies as a result of inadequate prey availability.

Metal and contaminant exposure remains a focus of ongoing investigation. Total mercury concentrations measured in hair samples collected from pups in the western-central Aleutian Islands were detected at levels that cause neurological and reproductive effects in other species (Rea et al. 2013).

5. ENVIRONMENTAL BASELINE

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. 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 areas that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR § 402.02).

This section focuses on existing anthropogenic and natural activities within the action area and their influences on the listed species and critical habitat that may be adversely affected by the proposed action. Although some of the activities discussed below occur outside of the action area, they may still impact listed species and/or habitat in the action area.

The majority of Alaska's population lives in the combined Anchorage/Matanuska-Susitna Boroughs; 39 percent of Alaska's population was in the Municipality of Anchorage and 15 percent was in the Matanuska-Susitna Borough in 2022.[14] Anchorage's population is projected to

[13] https://apps-afsc.fisheries.noaa.gov/REFM/docs/2022/GOA-ESR-Brief.pdf accessed July 2023.
[14] https://live.laborstats.alaska.gov/pop/index.html Accessed May 2023.

grow by 5 percent and the Matanuska-Susitna Borough population is projected to increase 44 percent between 2019 and 2045.[15] Upper Cook Inlet is exposed to more anthropogenic activities than most other locations in Alaska and there are multiple paths of potential habitat alteration and/or degradation. Marine mammals may be affected by multiple threats concurrently, compounding the impacts of individual threats. Anthropogenic risk factors are discussed individually below.

5.1 Recent Biological Opinions in the Action Area

NMFS AKR has long been issuing biological opinions for projects in upper Cook Inlet. Most of these consultations analyzed stressors that caused harassment rather than harm or mortality. Effects of these Cook Inlet actions (e.g., actions that caused acoustic harassment) on individual marine mammals are not measurable in the years following the action, and are believed to not have affected those marine mammals or their populations in any measurable way in the subsequent years. Some of these actions (e.g., construction of new oil rigs or ship terminals, filling of critical habitat in Turnagain Arm), however, have had broader environmental effects that last many years. Recent biological opinions issued by NMFS AKR for projects in upper Cook Inlet, include:

- Hilcorp Cook Inlet Tugs Towing a Jack-up Rig (AKRO-2021-03484), September 2022
- Port of Alaska's South Floating Dock (AKRO-2021-01051), Port of Alaska, August 2021
- Port of Alaska's Petroleum and Cement Terminal (AKRO-2018-01332), Port of Alaska, March 2020
- Alaska Liquefied Natural Gas Project (AKRO-2018-01319), Alaska Gasoline Development Corporation, June 2020
- 2019 U.S. Environmental Protection Agency's Proposed Approval of the State of Alaska's Mixing Zone Regulation Section of the State of Alaska's Water Quality Standards (AKRO-2018-00362), U.S. Environmental Protection Agency, July 2019
- Hilcorp Alaska and Harvest Alaska Oil and Gas Activities (AKRO-2018-00381), June 2019

These documents are available on the NOAA Fisheries website at: https://www.fisheries.noaa.gov/alaska/consultations/section-7-biological-opinions-issued-alaska-region. We discuss them below under headings that group together similar project types.

5.2 Coastal Development

While the majority of the Cook Inlet shoreline is undeveloped, there are municipalities, port facilities, airports, wastewater treatment plants, roads, mixing zones, and railroads that occur along or close to the shoreline. These include:

- emergency repairs of the Port MacKenzie facilities
- construction of oil and gas development-related facilities in Nikiski
- runway extensions at JBER and additional military aircraft overflights of Knik Arm

[15] https://live.laborstats.alaska.gov/pop/estimates/pub/19popover.pdf Accessed May 2023.

- POA construction of petroleum and cement terminal facilities and a South Floating Dock
- Highway realignment and bridge repair along Turnagain Arm

These and other projects are addressed in more detail below.

Beluga whales and Steller sea lions are particularly prone to regular interaction with human activities due to their frequent use of shallow, nearshore, and estuarine habitats (Perrin 1999). Cook Inlet beluga whales and Western DPS Steller sea lions use nearshore environments to rest, feed, give birth, and breed, and could be affected by coastal development. Humpback whales mostly occupy offshore areas and are less likely to be affected by coastal development activities.

5.2.1 Road Construction

The Alaska Department of Transportation (ADOT) began Seward Highway improvements from Mile 75 to 107 (along Turnagain Arm) in 2015. These activities included geophysical and geotechnical testing, on-shore blasting, pile removal and installation at stream crossings, fill placed into Turnagain Arm, and construction of a boat ramp at Windy Point. Activities also included resurfacing 15 miles of roadway, straightening curves, installing new passing lanes and parking areas, and replacing 8 existing bridges along the Seward Highway between mileposts 75 and 90.

The Seward Highway Milepost 75 to 90 Bridge Replacement project completed three bridge replacements by the end of 2019 during Phase 1. Phase 2 began in June 2021 with bridge work at Portage Creek #1 and the Placer River. This work is ongoing as is bridge work at the TwentyMile River. To avoid harassment of Cook Inlet beluga whales during the eulachon run, in-water work, including vibratory and impact pile installation and removal, will not occur from May 15 to June 15, and any work conducted below mean high water will require marine mammal monitoring.

Consultation on the Seward Highway mileposts 105-107 Windy Corner project was completed in 2015; however, the project has been delayed. The project plans to realign a 3.2 km segment of the highway and railroad, and includes land-based blasting and non-impulsive sound from fill placement. A Draft Environmental Assessment was made available to the public in March 2020, and ADOT extended the project north between Windy Corner and Rainbow Point (MP 105-109.5) after reviewing public comments. As of March 2023, the Seward Highway MP 105-109.5 Windy Corner to Rainbow Point project has been incorporated into the Seward Highway MP 98.5 to 118, Bird Flats to Rabbit Creek project, also known as the Safer Seward Highway project. Construction will be primarily seasonal and occur over multiple years.[16]

In 2020, NMFS completed consultation for a mitigation project in Portage Creek #2 to compensate for impacts expected to occur from the Windy Corner project. Work is expected to be completed by October 2023 and will remove forty deteriorating timber piles that once supported the Alaska Railroad bridge over Portage Creek #2. Project activities are restricted by seasonal timing to avoid the peak eulachon and salmon runs, and by daily tidal cycle to minimize

[16] https://www.windycorner.info/ Accessed May 2023.

potential interaction with belugas. Once the piles are removed, beluga whales will have unrestricted access to this salmon bearing creek.

5.2.2 Port Facilities

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

5.2.2.1 Port of Alaska

The Port of Alaska is Alaska's largest seaport. The POA handles half of all Alaska inbound fuel and freight, moving more than four million tons of material across its docks annually, which is distributed statewide and consumed by 90 percent of Alaska's population. Operations began in 1961 with a single berth, and have since expanded to include three cargo terminals, two petroleum terminals, one dry barge berth, two miles of rail-spur connected to Alaska Railroad, and two floating, small-vessel docks, plus 220 acres of land facility located in Anchorage.[17]

NMFS AKR issued a Letter of Concurrence for the POA Terminal 3 repair in 2015, which involved removal of a fender panel and installation of two 24-inch round piles (NMFS 2015). Mitigation measures were implemented to avoid take of marine mammals, and no take was authorized.

In 2016, NMFS AKR issued a biological opinion for the POA's Test Pile Program, which evaluated sound attenuation devices for potential use during port expansion projects (NMFS 2016a). The NMFS authorized Level B harassment takes for 26 Cook Inlet belugas and 6 Western DPS Steller sea lions. A single beluga whale was exposed to sound exceeding the Level B harassment threshold (Cornick and Seagars 2016).

NMFS AKR issued a Letter of Concurrence for the POA Fender Pile and Replacement Repair project in 2018, which included pile driving of 44, twenty-two-inch round piles (NMFS 2018e). Mitigation measures were implemented to avoid take of marine mammals, and no take was authorized. There were no sightings of protected species during pile driving activities.

The POA Modernization Program (PAMP) is comprised of multiple construction projects to update facilities for operational efficiency, accommodate modern shipping operations, and improve seismic resiliency. The Petroleum and Cement Terminal (PCT) is a pile-supported dock, comprised of an access trestle, loading platform, monopile breasting dolphins, monopile mooring dolphins, and related superstructure; Phase 1 was completed in 2020 and Phase 2 was completed in 2021. Fifty-five Level B harassment takes for Cook Inlet beluga whales were authorized and

[17] https://www.portofalaska.com/about-us/ Accessed May 2023.

26 exposures to sound exceeding the Level B harassment threshold were recorded during Phase 1 (61 North Environmental 2021). During Phase 2 activities, 27 of the 35 authorized Level B harassment takes were recorded (61 North Environmental 2022a).

In 2020 the POA applied for a USACE Nationwide Permit 3, Maintenance for the POA Fender Pile Replacement and Repair Project and NMFS AKR issued a Letter of Concurrence in 2021. The project will replace piles within the existing fendering system; inspections conducted before and after the 2018 Anchorage earthquake indicated the piles are in a state of imminent failure and require repair. The fendering system is comprised of 107 fender assemblies each supported by two pin piles. Twenty-three total fender assemblies were replaced in 2015 and 2019 (described above). The remaining fender assemblies were repaired except for one fender, which is expected to be completed in 2023.

Another component of the PAMP involved relocating the existing South Floating Dock (SFD), which is a relatively small structure used to stage and support small vessels, such as first-responder rescue craft, small work skiffs, and occasionally tugboats, in an area close to the daily operations at the POA. The existing SFD structure was removed and a new dock was constructed in May and June of 2022. Twenty-four Level B harassment takes for Cook Inlet beluga whales were authorized and two exposures to sound exceeding the Level B harassment threshold were recorded.

Maintenance dredging at the POA began in 1965, and is an ongoing activity from April through October in most years, affecting about 100 acres of substrate per year. The POA is dredged to the depth of -35 ft below mean lower low water (MLLW) and dredged materials are dumped 3,000 ft abeam of the POA dock face at the Anchorage in-water disposal site. To accommodate vessels berthing at the PCT location, transitional dredging to a depth of -40 ft MLLW began in 2018, and dredged material in the offshore disposal area (NMFS 2018c). Dredging at the POA has not been identified as a source of re-suspended contaminants (USACE 2009), and belugas often pass near the dredge (USACE 2008, ICRC 2012, POA 2019, USACE 2019). NMFS continues to analyze data to assess whether belugas react to dredging operations.

Dredging operations also occur annually at the Ship Creek Boat Ramp, located approximately 1.4 km southwest of the POA. The dredging at this site is done in three to four days when the area is dewatered. Heavy machinery pushes the accumulated sediment around the boat ramp seaward. NMFS AKR issued a Letter of Concurrence for Ship Creek dredging in 2020.

5.2.2.2 Port MacKenzie

Port MacKenzie is located along western, lower Knik Arm. Coastal development began with the construction of a barge dock in 2000. Additional construction and bulkhead repair activity has occurred since then; Port MacKenzie consists of a 152 m bulkhead barge dock, a 366 m deep draft dock with a conveyor system, a landing ramp, and more than 8,000 acres of adjacent uplands. Current operations may include dry bulk cargo movement and storage, depending on the current state of the port and existing demand for its facilities. The seawall to this port failed twice (in the winter of 2015-2016 and 2016-2017), necessitating emergency pile driving and other repair measures. Emergency NMFS consultations occurred after much of the repair work was completed. Marine mammal monitoring occurred on-site during pile driving operations in April 2016, and observers recorded belugas in or near the pile driving exclusion zone on 12 occasions. Pile driving was not occurring during these close approaches and no takes or shut-downs were recorded (Nuka Research and Planning Group 2016). Multiple groups of belugas were observed in this area between April and September 2020 and 2021 during monitoring for the POA PCT construction (61 North Environmental 2021, 2022a).

5.2.2.3 Other Ports

The next closest port is located in Nikiski, approximately 95 km to the southwest. Nikiski is home to several privately owned docks including the Offshore Systems Kenai dock. Activity at Nikiski includes the shipping and receiving of anhydrous ammonia, dry bulk urea, liquefied natural gas, sulfuric acid, petroleum products, caustic soda, and crude oil. In 2014, the Arctic Slope Regional Corporation expanded and updated its Rig Tenders Dock in Nikiski, in anticipation of increased oil and gas activity.

Western DPS Steller sea lions are affected by activities at ports throughout their range, especially where fish processing and noise overlap. In Cook Inlet, port activities in Homer, Port Graham, and Nikiski are most likely to affect Western DPS Steller sea lions. Ladd Landing Beach, located near Tyonek, serves as public access to the Three Mile subdivision and a staging area for various commercial fishing sites in the area.

5.3 Oil and Gas Development

Cook Inlet is estimated to have 500 million barrels of oil and over 19 trillion cubic feet of natural gas that are undiscovered and technically recoverable (Wiggin 2017). There may also be unconventional oil and gas accumulations of up to 637 billion cubic feet of gas and 9 million barrels of natural gas liquids (Schenk et al. 2015).

Lease sales for oil and gas development in Cook Inlet began in 1959 (Alaska Department of Natural Resources 2014), and there were attempts at oil exploration along the west side of Cook Inlet prior to that. Fourteen offshore oil production facilities were installed in upper Cook Inlet by the late 1960s, and today there are 17 offshore oil and gas platforms. Figure 15 shows the ongoing oil and gas activities in state waters as of December 2022. There are 203 active oil and gas leases in Cook Inlet that encompass approximately 416,573 acres of State leased land, of which 331,971 acres are offshore (Figure 16).[18]

Approximately 3.3 million acres were up for bid in the state-owned lease sale in June 2021, and HEX Group and Strong Energy Resources successfully bid on nearly 21,000 acres of oil and gas tracts in Cook Inlet. Hilcorp successfully bid on nearly 23,000 acres of oil and gas tracts in the December 2022 state-owned lease sale.

BOEM held Lease Sale 244 in Cook Inlet in 2017 (NMFS 2017b). Hilcorp was the only

[18] https://dog.dnr.alaska.gov/Documents/Leasing/PeriodicReports/Lease_LASActiveLeaseInventory.pdf Accessed May 2023.

responding company and their successful bids on 14 of 224 tracts/blocks offered encompassed 31,005 acres. NMFS issued Incidental Take Regulations for Hilcorp's oil and gas activities (NMFS 2019b); the seismic surveys, and other activities are discussed below. Lease Sale 258 in Cook Inlet was cancelled in May 2022 due to lack of industry interest; however, BOEM was directed by the Inflation Reduction Act of 2022 to hold Lease Sale 258 by the end of 2022 (Figure 17). One bid on one block was received and awarded to Hilcorp in March 2023.

5.3.1 Kenai Liquefied Natural Gas Plant

The Kenai liquefied natural gas (LNG) liquefaction and terminal complex began operating in 1969 and, until 2012, was the only facility in the United States authorized to export LNG produced from domestic natural gas. LNG shipments from the terminal began declining and the plant has been in a warm-idle state since 2015. In early 2019, NMFS was informed that there were plans to bring the plant back into operation in the next few years. The Federal Energy Regulatory Commission (FERC) approved the Trans-Foreland Pipeline Company's request to convert the facility to an importing plant in December 2020 and gave the company until December 2022 to place it into service. Trans-Foreland requested an extension to complete the facility by December 2025, which FERC approved in August 2022.[19]

Oil and gas development will likely continue in Cook Inlet; however, the overall effects on listed marine mammals are unknown (NMFS 2008a, b). The Cook Inlet Beluga Recovery Plan identified potential impacts from oil and gas development, including increased noise from seismic activity, vessel traffic, air traffic, and drilling; discharge of wastewater and drilling muds; habitat loss from the construction of oil and gas facilities; and, contaminated food sources and/or injury resulting from an oil spill or natural gas blowout (NMFS 2016b).

[19] https://www.reuters.com/business/energy/marathon-gets-more-time-build-lng-import-project-alaska-2022-08-16/ Accessed May 2023.

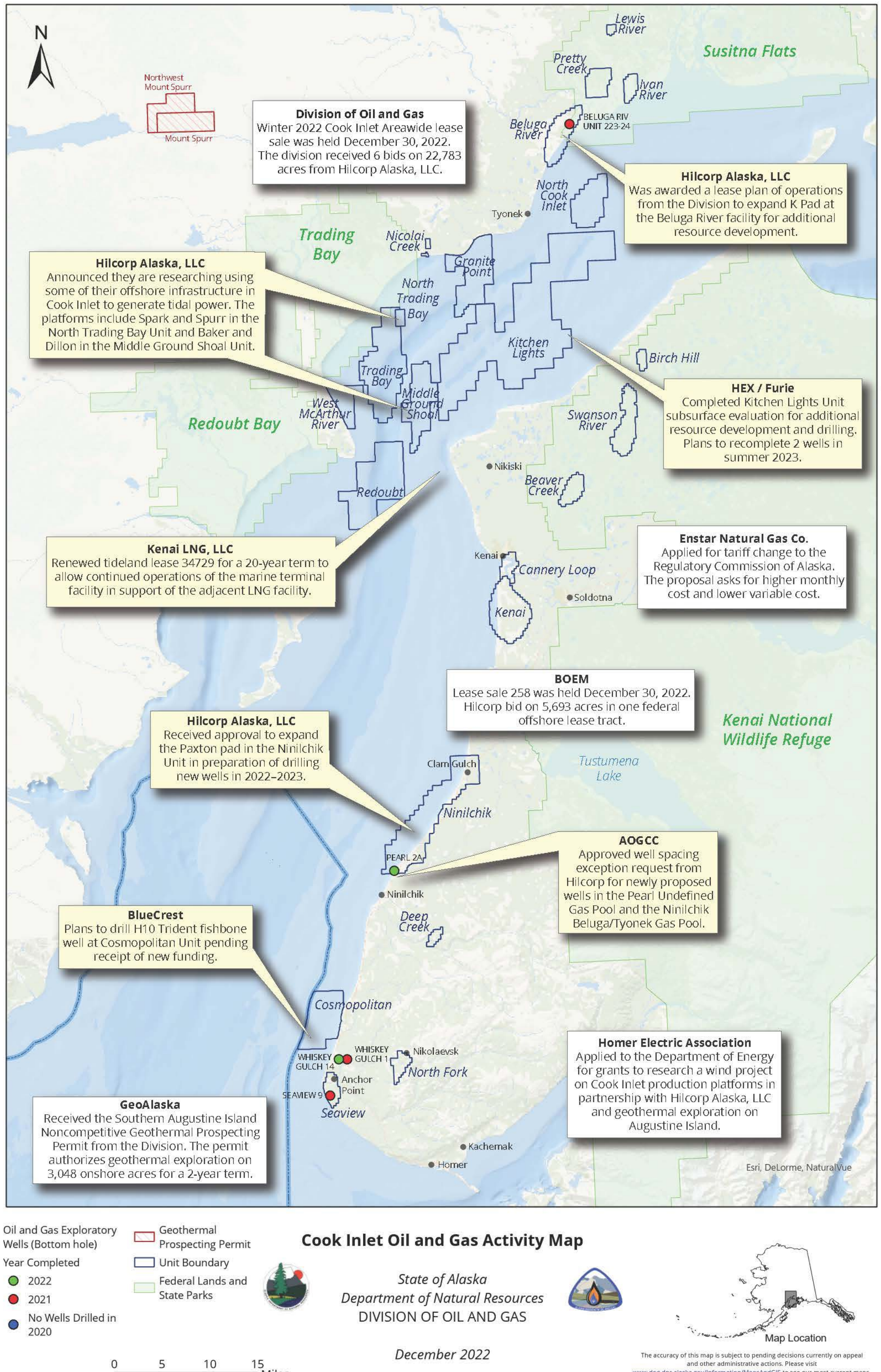

Figure 15. Oil and gas activity in Cook Inlet as of December 2022.

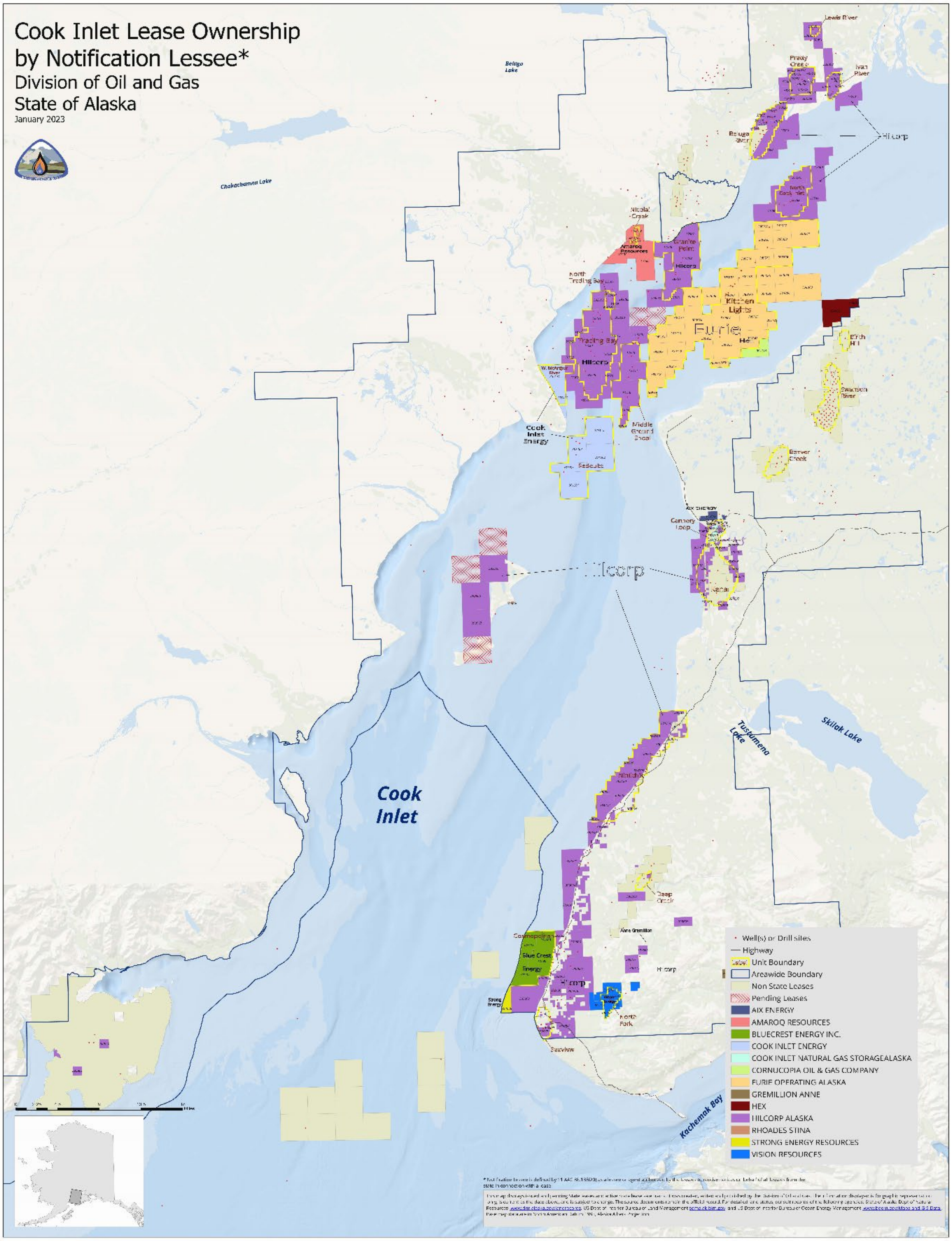

Figure 16. Cook Inlet lease ownership by notification lessee.

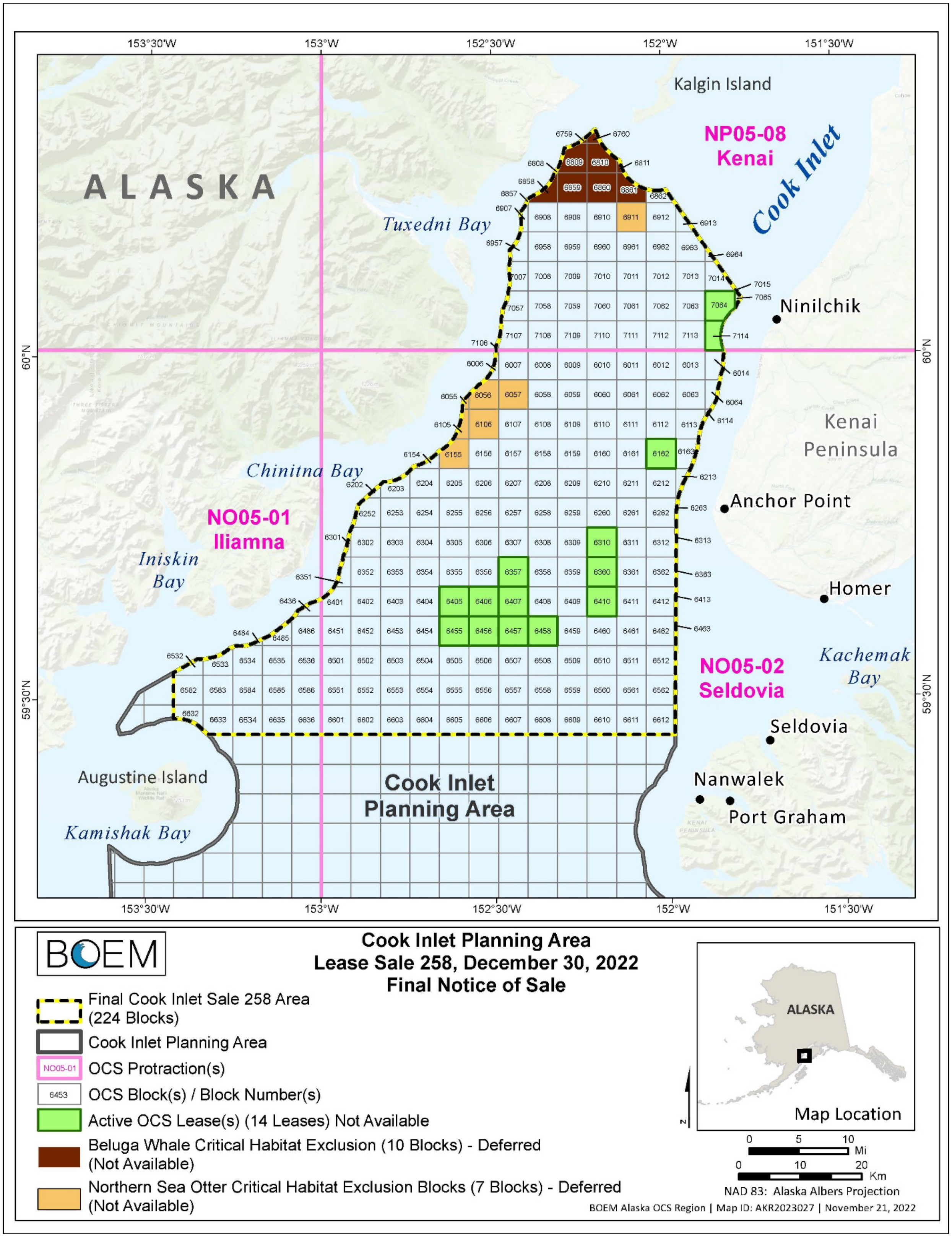

Figure 17. Lease Sale 258 Blocks.

5.4 Underwater Installations

The majority of underwater installations in Cook Inlet are oil and gas pipelines, which are an essential part of oil and gas activities in the area. The Cook Inlet basin is the source for all natural gas used in south-central Alaska. Communication cables have also been laid and a project to harness tidal energy is in the initial stages of development.

Installation of pipelines involves multiple vessels; anchor-handling tugs are used to reposition the anchors of a non-motorized pipe-laying barge, which is used to weld the pipeline that is laid over the back of the barge and into the trench. The tugs rely on their bow-thrusters while repositioning the anchors to keep the barge properly positioned and moving along. These projects involve disturbance to the substrate, increased turbidity in the vicinity of the trenching, and increased sound from the tugboats and pipe-laying equipment.

There is always a possibility of pipeline failures associated with oil and gas development, with resultant oil spills, gas leaks, or other sources of marine petrochemical contamination. Spills and contaminants are discussed below.

5.4.1 Hilcorp Cook Inlet Pipeline Cross Inlet Extension

Harvest, Alaska LLC, a subsidiary of Hilcorp Alaska, extended the existing undersea pipeline network in Cook Inlet and connected the Tyonek platform to the land-based pipeline located about 6.4 km north of the village of Tyonek in 2018. The cross-inlet extension included two steel subsea pipelines 25 cm and 20 cm in diameter, and 8.9 km in length. The existing 25 cm subsea pipeline that crosses Cook Inlet between Kaloa Junction and the East Forelands Facility was also converted from natural gas service to oil service. The IHA authorized Level B harassment of 40 Cook Inlet beluga whales, 6 Steller sea lions, and 5 humpback whales (NMFS 2018d). PSOs observed 814 beluga whales, 3 humpback whales, and 2 Steller sea lions during project activities; however, of the 819 listed animals observed, only 1 humpback was considered exposed to sound exceeding the Level B harassment threshold (Sitkiewicz et al. 2018).

5.4.2 Alaska LNG Project

The Alaska LNG Project proposes to carry natural gas from the North Slope to southcentral Alaska for export internationally, eventually shipping up to 2.4 billion cubic feet of LNG per day. Proposed infrastructure includes an approximately 1,290 km long, large diameter pipeline from the North Slope that would cross Cook Inlet north of the Forelands and terminate at a proposed liquefaction facility in the Nikiski area on the Kenai Peninsula. Five years of construction are anticipated for the Cook Inlet portion of the project. ESA consultation was completed in June 2020; the project is expected to result in Level B harassment of 61 Cook Inlet beluga whales, and 1 Mexico and 1 WNP DPS humpback whale over five years of work. One Mexico DPS humpback whale may also be exposed to sound levels exceeding the injury threshold. No effects to Steller sea lions are expected. As of yet, there is no planned project start date for the project and no construction has occurred.

5.4.3 Tidal Energy Project

Ocean Renewable Power Company (ORPC), a developer of renewable power systems that harness energy from free-flowing rivers and tidal currents, submitted a preliminary permit application to FERC in May 2021 for a project in Cook Inlet. ORPC previously conducted site characterization and environmental studies in the region, and intends to develop a five megawatt pilot project near East Foreland to verify the technical performance and environmental compatibility of its proposed project. Project results will assist in planning a phased build-out of up to a 100 megawatt commercial-scale project.[20] ORPC will collaborate with Homer Electric Association, Inc. to sell the tidal energy produced. Work on this project has not begun, nor have proposed construction dates been conveyed to NMFS.

ORPC is also partnering with the Matanuska-Susitna Borough to test its RivGen Power System at Port MacKenzie.[21] They plan to evaluate the ability to harness the tidal current of upper Knik Arm to power the cathodic protection systems at the port, which prevent the metal structures from corroding.

5.5 Natural and Anthropogenic Sound

Because sound is a primary source of disturbance to marine mammals, this opinion considers it as a separate category of the Environmental Baseline, although it is generally attributable to other factors in the Baseline, such as coastal and off-shore development.

Underwater sound in Cook Inlet is categorized as physical sound, biological sound, and human-caused sound. Natural physical sound originates from wind, waves at the surface, currents, earthquakes, ice movement, tidal currents, and atmospheric sound (Richardson et al. 1995). Tidal influences in Cook Inlet are a predominant contributor of physical sound to the acoustic environment (Burgess 2014, BOEM 2016).

Biological sound includes sounds produced by marine mammals (particularly whales and dolphins, but also pinnipeds), fish (Maruska and Mensinger 2009), and invertebrates (Chitre, Ong and Potter 2005). Human-caused sound includes vessel motor sounds, oil and gas operations, maintenance dredging, aircraft overflights, construction noise, and infrastructure maintenance noise. Much of upper Cook Inlet is a poor acoustic propagation environment due to shallow depths and sand and mud bottoms.

5.5.1 Seismic Surveys in Cook Inlet

Cook Inlet has a long history of oil and gas activities including seismic exploration, geophysical and geological surveys, exploratory drilling, increased vessel and air traffic, and platform production operation. Seismic surveys use high energy, low frequency sound in short pulse durations to characterize subsurface geology, often to determine the location of oil and gas reserves. Geophysical seismic activity has the potential to harass or harm marine mammals

[20] https://www.renewableenergymagazine.com/ocean_energy/orpc-plans-to-advance-tidal-energy-in-20210526 Accessed May 2023.
[21] https://www.akbizmag.com/industry/energy/testing-tidal-power-in-knik-arm/ Accessed May 2023.

(Nowacek et al. 2015).

Large airgun arrays of greater than 3,000 in^3, which can produce sound source levels exceeding 240 dB re 1 μPa rms, were previously used for seismic exploration in Cook Inlet. Smaller arrays are now being used because of the generally shallow water environment and the increased use of ocean-bottom cable and ocean-bottom node technology (Boman 2012). Shallow water surveys have employed 440, 620, and 880 in^3 arrays with source sound pressure levels less than 230 dB re 1 μPa rms. Measured radii to the 160 dB harassment isopleths have ranged from 3 to 9.5 km.

5.5.1.1 Apache Seismic Exploration

Apache Alaska Corporation conducted over 1,800 hours of seismic activity in 2012 and reported zero takes of beluga whales and Steller sea lions; however, observations of protected marine mammals within ensonified zones prior to equipment power-down or shutdown occurred on numerous occasions (Lomac-MacNair, Kendall and Wisdom 2013).

In 2014, observers recorded takes of 12 beluga whales and 2 humpback whales during 3,029 hours of observation effort. Additionally, four beluga whale groups were recorded less than 500 m from the source vessel during seismic operations (Lomac-MacNair, Thissen and Smultea 2014). The monitoring report is ambiguous, and it is unclear if the seismic guns were firing during those sightings. If the airgun array was operating, the groups were exposed to sounds exceeding the Level A injury threshold. A humpback whale was observed 1.5 km from the sound source when the airgun array was at full volume. Seismic operations were shut down immediately; however, it is estimated that the whale was exposed to at least 19 shots exceeding the Level A injury threshold. Regardless of immediate power-down or shutdown actions, an animal is considered exposed if it is within the respective Level A or Level B isopleths while sound is occurring.

5.5.1.2 SAE 3D Seismic Exploration

Eight vessels were deployed during SAE seismic operations in upper Cook Inlet in 2015. Of the total number of visual observations and acoustic detections, 194 animals were exposed to sounds exceeding the harassment threshold and 13 animals were exposed to sounds exceeding the injury threshold (Kendall et al. 2015). Species exposed to sounds exceeding the harassment threshold included an unidentified large cetacean, two belugas, and a Steller sea lion. A Steller sea lion was also exposed to sounds exceeding the injury threshold. Mitigation measures (clearance, ramp-up, and shut down procedures) prevented take during an additional 70 sightings (Kendall et al. 2015).

5.5.1.3 Hilcorp 3D Seismic – Lower Cook Inlet, Outer Continental Shelf

Hilcorp conducted a 3D seismic survey of approximately 790 km^2 over eight Outer Continental Shelf lease blocks in Lower Cook Inlet in 2019. One source, two support, and one marine mammal mitigation vessel were deployed. A Steller sea lion and a fin whale were observed in the Level A zone during seismic activity; however, permanent threshold shift or Level A take was unlikely because shut downs were implemented within a one-shot period. Level A injury thresholds are calculated with the assumption that an animal remains within the zone for 24 hours before an animal has a permanent threshold shift. Based on actual observed take and extrapolated estimates of take in light of those observations, 10.9 fin whales, 31.5 humpback whales, and 4.9 Steller sea lions were exposed to sounds exceeding the Level B harassment threshold during the project (Fairweather Science 2020).

Hilcorp submitted an IHA application to the NMFS Permits Division in September 2023 to conduct a 2D seismic survey using a 1,760 cubic inch (cui) airgun array during the open water season of 2024. The in-water survey will be conducted in the marine and intertidal waters on the eastern side of Cook Inlet from Anchor Point to Nikiski. The survey design includes 15 survey lines, approximately 4 km in length, running perpendicular to the shoreline from the Alaska state water boundary toward shore. Hilcorp plans to collect one source line per day, for an estimated 15 days of survey effort, with seismic activity occurring 1 to 2 hours in each 24-hour period.

5.5.1.4 Military Detonations

NMFS consulted on winter live-fire weapons training on the Eagle River Flats (ERF) Impact Area at JBER in 2016. Live-fire training uses firing positions on a designated range facility, at predetermined targets, in a controlled access area known as an impact area. ERF has been used as a dudded impact area since about 1945. A dudded impact area is an area having designated boundaries within which all dud producing ordnance will detonate on impact. This area may include vehicle bodies that serve as targets for artillery/mortar direct and indirect fire. The current winter-only firing restriction has been in place since 1991.

Cook Inlet beluga whales may be able to hear sounds from JBER while they are in coastal waters near the firing range; however, NMFS determined that low frequency impulses from exploding ordnance are not expected to cause noise levels of concern. Adverse effects are extremely unlikely because belugas are not expected to be present in the winter when firing occurs, no measurable effects on their prey base are expected, and mitigation measures are in place to further lessen the chances of any take by harassment. JBER measured the acoustic propagation and developed buffer zones to ensure sound that reaches Eagle Bay falls below 160 dB_{rms} re 1μPa, the Level B take threshold for non-continuous sound for cetaceans. NMFS concluded that acoustic effects on belugas associated with the action were discountable.

5.5.2 Oil and Gas Exploration, Drilling, and Production Noise

With frequencies generally below 10 kHz, operating sounds from the oil platform itself are louder than the sound generated by drilling. Noise from the platform is thought to be weak due to the small surface area (the four legs) in contact with the water (Richardson et al. 1995), and that the majority of the machinery is on the deck of the platform above the water surface. Blackwell and Greene (2003) recorded underwater sound produced at Phillips A oil platform (now the Tyonek platform) at distances ranging from 0.3 to 19 km from the source. The highest recorded sound level was 119 dB at a distance of 1.2 km. Sound between 2 and 10 kHz was measured as high as 85 dB as far out as 19 km from the source. This noise is audible to beluga and humpback whales, and Steller sea lions.

5.5.2.1 ExxonMobil Alaska LNG, LCC

In 2016, ExxonMobil Alaska conducted geophysical and geotechnical surveys in upper Cook Inlet within the Susitna Delta Exclusion Zone (SUDEX). Two sightings of beluga whales (four individuals) and one sighting of a harbor seal were observed within the SUDEX. The sightings occurred during non-operational periods (e.g., when no vibracore operations were occurring), and both beluga sightings were observed outside of the harassment zone (Smultea Environmental Sciences 2016).

5.5.2.2 Furie Exploration Drilling

NMFS completed formal consultation in 2017 for Furie to conduct oil and gas exploratory drilling operations in the Kitchen Lights Unit in upper Cook Inlet between 2017 and 2021 (NMFS 2017a). Actions included tugs towing a jack-up rig from winter storage in lower Cook Inlet to the drilling sites, high-resolution geophysical surveys, pile driving at the drilling locations, drilling operations, vessel and air traffic associated with rig operations, fuel storage, and well completion activities. Furie did not conduct exploratory drilling in 2017 and requested reinitiation in late 2017 after modifying the proposed actions. NMFS completed an informal consultation on the updated action, concurring that that action was not likely to adversely affect listed species or critical habitat and no take was authorized (NMFS 2018b). PSOs monitored during pile driving in June 2018 and observed one beluga carcass unrelated to project activities (Jacobs Engineering Group 2019). The Kitchen Lights Unit was purchased by HEX LLC at a December 2019 bankruptcy auction.

5.5.2.3 Hilcorp Oil and Gas

The Hilcorp Incidental Take Regulations issued in 2019 included oil and gas exploration, development, production, and decommissioning activities in Cook Inlet between 2019 and 2024. As discussed above, Hilcorp completed seismic operations in 2019. Hilcorp completed routine pipeline maintenance operations in 2020 and did not observe any marine mammals. In 2021, three tugs transported the *Spartan 151* jack-up rig for plug and abandonment activities and production drilling. Hilcorp also completed a shallow hazard survey over lower Cook Inlet Outer Continental Shelf leases in 2021 to evaluate potential hazards, document any potential cultural resources, identify shallow hazards, obtain engineering data for placement of structures, and detect subsurface geologic hazards.

Hilcorp transported the jack-up rig from the Rig Tender’s Dock in Nikiski to the Tyonek platform in middle Cook Inlet in June 2022 and back to the Rig Tender’s Dock in September 2022. In 2023, Hilcorp transported the jack-up rig from the Rig Tender’s Dock to the subsea Well Site 17589 in June and to the Tyonek platform in July. NMFS Permits Division concurred with Hilcorp’s assessment that take of marine mammals by Level B harassment was unlikely to occur during the transport.

Hilcorp and Harvest also received a Letter of Concurrence from NMFS AKR in 2022 for routine oil and gas pipeline and infrastructure maintenance. Routine maintenance activities include: subsea pipeline inspections, pipeline stabilization, and repair and replacement; platform leg inspections and repairs; and anode sled installations. Work under the informal consultation will occur over a five-year period from 2022 – 2027.

Hilcorp submitted an IHA application to the NMFS Permits Division in September 2023 for oil and gas exploration, development, production, and decommissioning activities in Cook Inlet from April 1, 2024 to November 30, 2024. The application includes production drilling at existing platforms in middle Cook Inlet and Trading Bay using a jack-up rig towed by tugs. As discussed above, the IHA application also includes a 2D seismic survey.

5.5.3 Vessel Traffic

Cook Inlet is a regional hub of marine transportation throughout the year, and is used by various classes of vessels, including containerships, bulk cargo freighters, tankers, commercial and sport-fishing vessels, and recreational vessels. Vessel traffic density is concentrated along the eastern margin of the Inlet between the southern end of the Kenai Peninsula north to Anchorage. Vessel traffic in Cook Inlet transits through the ports Homer and Anchorage. Kachemak Bay, near Homer, typically has high levels of traffic with larger vessels entering the mouth of the bay to pick up a marine pilot or await U.S. Coast Guard inspection. The Bay also acts as a port of refuge for vessels sheltering from weather. On the west side of Cook Inlet, a substantial source of tanker traffic transported oil from the Drift River Terminal to the refineries on the east side, before being decommissioned.

Blackwell and Greene (2003) recorded underwater sound produced by both large and small vessels near the POA. The tugboat *Leo* produced the highest broadband levels of 149 dB re: 1 µPa at a distance of approximately 100 m, while the docked cargo freight ship *Northern Lights* produced the lowest broadband levels of 126 dB re: 1 µPa at 100 to 400 m. Continuous sound from ships generally exceeds 120 dB re 1 µPa rms to distances between 500 and 2,000 m (Jacobs Engineering Group 2017).

Cook Inlet belugas may be affected by the sound associated with shipping and transportation. There are anecdotal reports of belugas having varying reactions to vessel traffic; observers recorded diving, direction changes, and groups splitting when vessels and whales crossed paths in close proximity (HDR 2015 unpublished data). During other observations, beluga behavior suggested the whales were habituated to the vessels. Blackwell and Greene (2003) speculated belugas may habituate and become tolerant of vessels in areas subjected to perennial boat traffic.

Belugas may also decrease or cease vocalizations in response to sounds from ships and other activities, or their vocalizations may be masked (Castellote et al. 2016b). Scheifele et al. (2005) studied a population of belugas to determine whether beluga vocalizations showed intensity changes in response to shipping noise, and found that shipping noise caused belugas to vocalize louder. Lesage et al. (1999) described more persistent vocal responses when whales were exposed to a ferry as opposed to a small-boat, including a progressive reduction in calling rate while vessels were approaching, an increase in the repetition of specific calls, and a shift to higher frequency bands when vessels were close to the whales. Belugas altering their vocal behavior is indicative of an increase in energy costs, and long-term adverse energetic consequences could occur, if noise exposure is chronic. The degradation of the beluga acoustic communication and echolocation space, as well as the noise-induced chronic increase of signaling costs and stress, could lead to negative biological consequences at the population level (NMFS 2016b).

Some baleen whales have adjusted their communication frequencies, intensity, and call rate to limit masking effects from anthropogenic sounds such as shipping traffic. Baleen whales may also exhibit behavioral changes in response to vessel noise. Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting behavioral states to active behavioral states, suggesting an energetic cost to the affected animal. Humpback cow-calf pairs significantly reduced the amount of time spent resting and milling when vessels approached, as compared to undisturbed whales (Morete et al. 2007). Responding to vessels is likely stressful to humpback whales, but the biological significance of that stress is unknown (Bauer and Herman 1986).

Potential impacts of vessel disturbance on Steller sea lions have not been well studied, and the responses will likely depend on the season and stage in the reproductive cycle (NMFS 2008b). Steller sea lions are more likely to be disturbed at haulouts and near rookeries, where in-air vessel noise or visual presence could cause behavioral responses such as avoidance of the sound source, spatial displacement from the immediate surrounding area, trampling, and abandonment of pups (Calkins and Pitcher 1982, Kucey 2005). Repeated disturbances that result in abandonment or reduced use of rookeries by lactating females could negatively affect body condition and survival of pups through interruption of normal nursing cycles (NMFS 2008b). Increases in ambient noise from vessel traffic, however temporary, also have the potential to mask communication between sea lions and affect their ability to detect predators (Richardson and Malme 1993, Weilgart 2007).

5.5.4 Aircraft Sound

There is significant air traffic over Cook Inlet. Ted Stevens Anchorage International Airport, located adjacent to lower Knik Arm, is the largest air cargo hub in the U.S. and also has high volumes of commercial air traffic. Joint Base Elmendorf-Richardson (JBER) has a runway near Knik Arm and airspace directly over it. Lake Hood in Anchorage is the largest and busiest seaplane base in the world, and the only seaplane base in the U.S. with primary airport status (Federal Aviation Administration 2016). Small public runways are located in Birchwood, Goose Bay, Merrill Field, Girdwood, Kenai, Ninilchik, Homer, and Seldovia. Oil and gas operators frequently utilize helicopters and fixed-winged aircraft to transport personnel and goods, as well as for surveys.

Airborne sounds do not transfer well to water; much of the sound is attenuated at the surface or reflected where angles of incidence are greater than 13°. However, loud aircraft sound can be heard underwater when aircraft are within or near the 13° overhead cone and surface conditions are calm (Richardson et al. 1995). The sound and visual presence of aircraft may result in behavioral changes in whales, including diving, altering course, vigorous swimming, and breaching (Patenaude et al. 2002).

NMFS consulted on a proposed action to improve F-22 aircraft operational efficiency at JBER in

2016. The Air Force modeled the in-water sound pressure level of an F-22 overflight and determined the maximum predicted in-water sound was 136.8 dB re 1 µPa rms for a duration of a few seconds. The estimated total time per flight event in flight configurations that result in underwater sound levels greater than 120 dB re 1 µParms was between 3 and 136 seconds, with the number of seconds depending on the flight procedure being conducted. Due to the airspeed of the F-22, at any given point within the overflown portion of Cook Inlet waters, exposures to underwater sound levels greater than 120 dB re 1 µParms would be very brief—approximately 2 to 5 seconds. The number of beluga behavioral reactions associated with the proposed action was estimated at 0.012 to 0.047 per year. Based on the short time during which any increased noise would be detectable to belugas, and the low probability of belugas occurring within the path of maximum sound pressure level, NMFS concluded that acoustic effects on belugas associated with the proposed action were insignificant and discountable.

Observers reported little or no change in swimming direction of beluga whales in Cook Inlet in response to the survey aircraft flying at approximately 244 m (Rugh, Shelden and Mahoney 2000). Beluga whales in the Beaufort Sea were observed diving or swimming away when low-flying aircraft passed above (500 m; Richardson et al. 1995). Individual responses of belugas may vary depending on previous experiences, beluga activity at the time of the sound, and sound characteristics.

The responsiveness of baleen whales (i.e., humpbacks) to aircraft is also variable and may depend on behavioral state, habitat, and age class of the animal. Responses include diving and turning, as well as other changes in behavior. Whales actively engaged in feeding or social behavior often appear less sensitive, and typically do not exhibit a reaction. Whales with calves or in confined waters may be more sensitive. Single or occasional aircraft overflights do not seem to cause long-term displacement or abandonment by whales (Richardson et al. 1995).

Aircraft may also disturb Steller sea lions, especially if hauled out. Disturbance of a rookery or haulout has the potential to result in serious injury or death, predominantly from trampling. Over 1,000 sea lions were observed stampeding off a beach in response to a large helicopter over a mile away (Withrow 1982). There are no rookeries or haulouts within Cook Inlet.

5.6 Sound and Habitat

A wide variety of anthropogenic sound sources are present in and around Cook Inlet beluga whale habitat. Anthropogenic sound occurs year-round; however, many of the sources are seasonal and only present during the ice-free months. Sound sources include tugs, tankers, cargo ships, fishing vessels, small recreational vessels, dredging, pile-driving, military detonations, and seismic surveys (NMFS 2016b).

The limited scientific literature on the effects of sound on fish indicates that sound can evoke a variety of responses. Pile driving can induce a startle and/or avoidance response, and can cause injury or death to fish close to the sound source (McCauley, Fewtrell and Popper 2003, Slabbekoorn et al. 2010, Casper et al. 2012, Halvorsen et al. 2012). Fish will likely avoid sound sources within ranges that may be harmful (McCauley, Fewtrell and Popper 2003).

Coho salmon (*Oncorhynchus kisutch*), a Cook Inlet beluga and Steller sea lion prey species, were exposed to pile driving sound in a laboratory environment (Casper et al. 2012, Halvorsen et al. 2012). Very high sound level exposures (210 dB re 1µPa_{rms}) were required to meet the threshold for onset of injury, suggesting that one or two mild injuries resulting from pile driving exposure at these or higher levels were unlikely to affect the survival of the exposed animals. Rodkin (2009) studied the effects of pile driving sheet piles on juvenile coho salmon at the POA. The fish were exposed to in-situ sound from vibratory or impact pile driving at distances ranging from less than 1 meter to over 30 meters. There was no mortality of any test fish within 48 hours of exposure to the pile driving activities, and subsequent necropsies found no effects or injuries. The effects of sound on other prey species, such as eulachon, gadids, and flounder species, are unknown (NMFS 2008b, 2016b).

5.7 Water Quality and Water Pollution

The Cook Inlet region is the most populated and industrialized region of the state. Its waters receive various pollutant loads through activities that include urban runoff, oil and gas activities, municipal sewage treatment effluents, oil and other chemical spills, fish processing, and other regulated discharges. The main sources of pollutants likely include the 10 wastewater treatment facilities, stormwater runoff, airport de-icing, military training at Eagle Bay, and discharge from oil and gas development (Moore et al. 2000, NMFS 2008a). Emerging pollutants of concern from municipal sewage include endocrine disruptors (substances that interfere with the functions of hormones), pharmaceuticals, personal care products, prions (infectious proteins that cause neurodegenerative disease), and other bacterial and viral agents that are found in wastewater and biosolids (NMFS 2016). Many pollutants are regulated by the Environmental Protection Agency (EPA) or the Alaska Department of Environmental Conservation (ADEC), who may authorize certain discharges under the National (or Alaska) Pollution Discharge Elimination System (NPDES/APDES; section 402 of the Clean Water Act of 1972).

Cook Inlet beluga whales are exposed to chemical concentrations that are typically lower than those experienced by other Arctic marine mammals (Becker et al. 2000, Becker et al. 2010). Levels of heavy metals, pesticides, petroleum hydrocarbons, and polychlorinated biphenyl (PCB) compounds found in Cook Inlet's water column and sediments were below detection limits; and heavy metal concentrations were below management levels (KABATA 2004, NMFS 2008a, USACE 2008). The comparatively low levels of contaminants documented in the Cook Inlet water and sediment samples, as well as in the belugas themselves suggests that the magnitude of the pollution threat appears low.

5.7.1 Petrochemical Spills

According to the ADEC, oil spills in marine waters consist mostly of harbor and vessel spills, and spills from platform and processing facilities. A spill baseline study conducted as part of the Cook Inlet Risk Assessment estimated a historical vessel spill rate of 3.4 spills (regardless of size) per year, with rates ranging from 0.7 spills per year for tank ships to 1.3 spills per year for non-tank/non-workboat vessels (Nuka Research and Planning and Pearson Consulting LLC 2015). Between 1966 and 2015, eight large vessel spills (≥ 1,000 bbl) were documented in Cook

Inlet (BOEM 2016). The ADEC Statewide Oil Spills Database[22] provides public access to data on all the spills reported in Cook Inlet or in tributaries to Cook Inlet. The types of spills recorded include jet fuel, crude oil, ethylene glycol, and produced water. Spills of as little as one gallon are reported and most spills are contained and disposed of properly. Eleven spills have been recorded so far in 2023, 14 in 2022, 21 in 2021, 12 in 2020, and 18 in 2019.

Given the amount of oil and gas production and vessel traffic, spills of petroleum products are a threat to marine mammals inhabiting Cook Inlet. Oil spills that occur in or upstream of Cook Inlet could result in marine mammals having direct contact with the oil, which could affect the skin and/or respiratory systems. Research indicates cetaceans are capable of detecting oil, but they do not seem to avoid it (Geraci and St. Aubin 1990), and oil has been implicated in the deaths of pinnipeds, including Steller sea lions (St. Aubin 1990).

Cook Inlet beluga whales could be affected through residual oil from a spill, even if they were not present during the oil spill, due to the highly mobile nature of oil in water and the extreme tidal fluctuations in Cook Inlet (NMFS 2008a). Prey contamination is also likely, but the effect of contaminated prey on belugas remains unknown. Polycyclic aromatic hydrocarbons (PAHs), a group of contaminants found in petroleum products, combined with other contaminants, may cause cancer in beluga whales (Kingsley 2002). Cook Inlet belugas appear to be bioaccumulating PAHs from the environment and prey (Norman et al. 2015). Spill clean-up efforts could also result in displacement of whales from essential feeding areas.

Pinnipeds exposed to oil at sea through incidental ingestion, inhalation, or limited surface contact do not appear greatly harmed by the oil; however, pinnipeds found close to the source or who must emerge directly in oil appear substantially more affected. Sea lions exposed to oil through inhalation, dermal contact and absorption, direct ingestion, or through the ingestion of prey may become heavily contaminated with PAHs. Toxic substances, such as oil, may be a contributing factor in the decline of the Western DPS Steller sea lion population (NMFS 2008b). While the Exxon Valdez oil spill occurred after the current Steller sea lion population decline began, the spill almost certainly exacerbated the decline. Mortalities from toxic contamination are strongly linked to this spill; 12 sea lion carcasses were found in Prince William Sound and 16 carcasses were found near Prince William Sound, along the Kenai coast and at the Barren Islands. Elevated PAH levels were present in the animals found dead shortly after the spill (NMFS 2008b).

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

An oil spill in Cook Inlet could also result in widespread habitat degradation, impacting beluga whales and putting the population at risk. Population level effects to the Western DPS of Steller

[22] https://dec.alaska.gov/Applications/SPAR/PublicMVC/PERP/SpillSearch Accessed May 2023.

sea lions and listed humpback whales within Cook Inlet would be far less likely; however, individual animals may also be put at risk from a spill.

The amount of oil and gas development and vessel traffic in and around Cook Inlet suggests that spills are inevitable. As a consequence, marine mammals and their prey may be exposed to a range of contaminants in varying concentrations. The long-term consequences of this exposure remain unknown. However, the statistical probability of large, and especially very large, oil spills occurring is very small (BOEM 2016). A number of regulatory changes have been put in place since the Deepwater Horizon oil spill in an effort to reduce the risk of spills associated with oil and gas development and production activities (e.g., prescriptive and performance based regulations and guidance, as well as OCS safety and environmental protection requirements (BOEM 2012). Small spills are expected to rapidly disperse due to tide-induced turbulence and mixing; large condensate and diesel fuel spills in Cook Inlet are expected to evaporate and disperse, generally within one to ten days, depending on size of spill (BOEM 2017).

5.7.2 Wastewater Discharge

Wastewaters entering treatment facilities may contain a variety of organic and inorganic pollutants, metals, nutrients, sediments, bacteria and viruses, and other emerging pollutants of concern; and, undergo primary, secondary, or tertiary treatment prior to being discharged into a body of water. Primary treatment involves sedimentation. In general, this includes removing 50 to 70 percent of the solid particulate from the wastewater prior to discharge (Sonune and Ghate 2004). In addition to sedimentation, secondary treatment involves adding a biological component to remove the remaining organic matter. Tertiary treatment involves both primary and secondary treatment as well as additional processes to increase the water quality of the discharge (Sonune and Ghate 2004).

Ten communities currently discharge treated municipal wastes into Cook Inlet. Wastewater from the Municipality of Anchorage, Nanwalek, Port Graham, Seldovia, and Tyonek receive primary treatment, wastewaters from Homer, Kenai, and Palmer receive secondary treatment, and wastewaters from Eagle River and Girdwood receive tertiary treatment.

The Anchorage John M. Asplund Wastewater Treatment Facility (AWTF) is the largest wastewater facility in Alaska and is located in upper Cook Inlet. AWTF provides primary treatment, and removes approximately 80 percent of solids prior to discharge. The facility was built in 1972, upgraded in 1982 and again in 1989. The Environmental Protection Agency (EPA) issues AWTF a waiver for secondary treatment because of the levels of sediment they are able to extract and the extreme tides and currents of Cook Inlet (Kinnetic Laboratories Incorporated 2017). Once the sediment is removed from the wastewater, the sludge is incinerated. The effluent is tested regularly, including bioassays on fish and invertebrates, and has shown very low levels of contaminants (Jokela et al. 2010).

The Village of Tyonek wastewater treatment facility operates on a gravity fed sewer that drains into a community septic tank. The solids are transferred to a sludge lagoon for dewatering twice a year and the liquid effluent is then discharged into Cook Inlet near an area heavily used by feeding Cook Inlet beluga whales. The City of Kenai wastewater facility is one of the larger plants and is located near the largest runs of salmon in Cook Inlet. Secondary-treated wastewater is discharged directly into Cook Inlet, and the sludge is taken to the Soldotna landfill.

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

5.7.3 Mixing Zones

In 2010, the EPA consulted with NMFS on the approval of ADEC's Mixing Zone Regulation section (18 AAC 70.240), including the most recent revisions of the Alaska Water Quality Standards (18 AAC 70; WQS), relative to the endangered Cook Inlet beluga whale (NMFS 2010b). The biological opinion concluded that there was insufficient information to determine whether belugas could be harmed by the elevated concentrations of substances present in mixing zones, but that the action was not likely to jeopardize the continued existence of the species. In 2019, NMFS issued a biological opinion on the effects of EPA approval of the Mixing Zone Regulation following designation of Cook Inlet beluga whale critical habitat and concluded that the Mixing Zone Regulation is not likely to destroy or adversely modify designated Cook Inlet beluga whale critical habitat.

5.7.4 Stormwater Runoff

Stormwater pollutants may include street and aircraft de-icer, oil, pesticides and fertilizers, heavy metals, and fecal coliform bacteria. Public Works and the Alaska Department of Transportation and Public Facilities are responsible for identifying, monitoring, and controlling pollutants in stormwater. The effects of stormwater on the Cook Inlet beluga whale have not been studied and are unknown (NMFS 2008a).

Numerous releases of petroleum hydrocarbons have been documented from the POA, JBER, and the Alaska Railroad Corporation (ARRC). The POA transfers and stores petroleum oils, as well as other hazardous materials. Since 1992, all significant spills and leaks have been reported. Past spills have been documented at each of the bulk fuel facilities within the POA and also on JBER's property (POA 2003). Joint Base Elmendorf-Richardson (JBER) is listed on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, because of known or threatened releases of hazardous substances, pollutants, or contaminants. Spills have also been reported at the ARRC rail yard. In 1986, petroleum seeped into Ship Creek from the nearby rail yard, and several oil spills occurred in 2001 (U. S. Army 2010). Freight handling activities have historically caused numerous surface stains and spills at the rail yard.

5.7.5 Aircraft De-icing

The Federal Aviation Administration requires de-icing and anti-icing of aircraft and airfield surfaces, when necessary, to ensure passenger safety. De-icing and anti-icing chemicals are used from October through May and may be used on aircraft, tarmacs, and runways. De-icing material is comprised of different chemicals depending on the application; ethylene glycol and propylene glycol are used on aircraft for anti-icing and de-icing purposes, whereas potassium acetate is used to de-ice tarmacs and runways.

The Ted Stevens Anchorage International Airport and Joint Base Elmendorf-Richardson airport are the largest airports in the Cook Inlet region. Other smaller airports exist throughout the Cook Inlet watershed, including Merrill Field, Lake Hood, Kenai, and Homer (NMFS 2008a). It is likely that they all regularly contribute pollutants to Cook Inlet through stormwater runoff; one of the stormwater outfalls from the Ted Stevens Anchorage International Airport enters Knik Arm directly. ADEC conducted inspections of the discharge from the outfall that discharges into Knik Arm in April 2009, May 2012, and April 2017 after complaints were received from the public (ADEC 2019). A frothy white foam with a sweet odor was determined to be deicing chemicals, and a Notice of Violation was recorded in all three years (ADEC 2019).

The current permit for the Ted Stevens Anchorage International Airport requires monthly sampling and reporting of several water quality standards, and an annual report for the outfall entering Knik Arm. Belugas primarily use the waters near the outfall as a transit corridor and their exposure to elevated levels of contaminants in April and May when the majority of runoff occurs is likely limited (ADEC 2019).

5.7.6 Ballast Water Discharges

Globally, shipping has been found to be responsible for 69 percent of marine invasive species (Molnar et al. 2008). The impact of nonnatives in marine systems includes extirpation of native species through competition or predation, shifts in ecosystem food webs, and changes to the physical structure of the habitat (Norse and Crowder 2005). The National Invasive Species Act of 1996 mandates that all ships arriving in U.S. waters complete and submit a ballast water information report to the National Ballast Water Information Clearinghouse.

Discharges of wastes from vessels are regulated by the United States Coast Guard (USCG) and, by law, no discharges of any kind are allowed within three miles of land. The USCG established rules for controlling discharged ballast water in U.S. waters through publication of 33 CFR Part 151 and 46 CFR Part 162 in 2004. Ships must manage their ballast water by the following treatment methods and good practices:

- Perform ballast water treatment through installation and operation of an approved Ballast Water Treatment System.
- Perform ballast water exchange 200 miles from shore.
- Avoid or minimize ballast water exchanges in risky or preserved areas.
- Clean ballast tanks regularly to remove sediments, rinse anchors and chains, and remove fouling from hull and piping.
- Maintain an approved Ballast Water Management Plan, as well as the written records of ballast water movements (uptake, transfer, discharge).

- Submit vessel and ballast water management information to USCG prior arrival in US harbors.

Before the problems with ballast water were fully recognized and regulated, untreated ballast water was released in Cook Inlet. The National Ballast Water Information Clearinghouse reported that more than five million metric tons of, likely untreated, ballast water were released in Cook Inlet between Homer and Anchorage from 1999 to 2003. Surveys conducted in Kachemak Bay and Cook Inlet in 2000 found 13 invasive species in diverse taxonomic groups, including 3 hydroids, 1 bryozoan, 2 bivalves, and 7 species of vascular plants (Hines and Ruiz 2000). When compared to similar surveys along the West Coast, there are relatively few invasives in Alaska's coastal waters (Ruiz et al. 2006). Dueñas et al. (2018) conducted a systematic literature review on invasive species' interactions with all ESA-listed species, and did not find any studies indicating that ESA-listed marine mammals were negatively impacted by invasive species.

The effects of discharged ballast water and the possible introduction of invasive species on Western DPS Steller sea lions, humpback whales, Cook Inlet beluga whales, and their designated critical habitat are unknown and any ecosystem level impacts will take many years to be manifested.

5.7.7 Contaminants Found in Listed Species

Studies conducted in upper Cook Inlet found polychlorinated biphenyls (PCB), pesticides, and petroleum hydrocarbon levels below detectable limits in the water column and sediment, and heavy metals were below management levels (KABATA 2004, NMFS 2008a, USACE 2008).

Becker et al. (2000) compared levels of PCBs, chlorinated pesticides, heavy metals, and other elements between beluga populations in Greenland, the St. Lawrence Estuary and Arctic Canada, and Cook Inlet, Point Hope, and Point Lay, Alaska. The Cook Inlet population had the lowest concentrations of PCBs, pesticides, cadmium, and mercury of all the populations, but had higher concentrations of copper than the other two Alaska populations. The lower levels might be related to differences in contaminant sources, food web differences, or different age distributions of the animals sampled. Concentration values of previously reported legacy organic contaminants in the Cook Inlet beluga whale population did not significantly change with the analysis of more recent samples; however, chemicals of emerging concern (e.g., polybrominated diphenyl ether, hexabromocyclododecane, and perfluorinated compounds) were identified. While the contaminant levels found in the Cook Inlet beluga whale population are lower than the levels in other populations, the effects of these contaminants on this population are unknown (Becker et al. 2000, NMFS 2008a).

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous in the environment, from both natural and anthropogenic sources, and are of special concern where they have the potential to be introduced at elevated concentrations from urban run-off, oil spills, municipal discharges, and oil and gas activities. High levels of PAHs have cytotoxic, genotoxic, immunotoxic, and carcinogenic effects on aquatic wildlife. In Cook Inlet, anthropogenic sources of hydrocarbons include oil and gas activities (e.g., produced water discharges), municipal wastewater discharge, stormwater runoff from roads and industrial areas, vessels, and spills (Saupe et al. 2014). The main, known natural sources in Cook Inlet include coal, oil seeps, peat, and hydrocarbon bearing source rock that enter Cook Inlet directly from rivers and coastal erosion, as well as from advection into the inlet (Saupe et al. 2014).

Beluga whales spend significant time in intertidal and nearshore areas, where the risk is often highest for exposure to PAHs (Saupe et al. 2014). Belugas may be exposed to PAHs through inhalation, direct contact with oil slicks or dissolved plumes, direct contact with contaminated sediments, or ingesting contaminated prey. Samples from belugas from the St. Lawrence Estuary, Cook Inlet, Arctic, and aquaria were analyzed, and significantly higher levels of intestinal PAH–DNA adducts were found in the St. Lawrence Estuary and Cook Inlet samples (Poirier et al. 2019). The presence of such an adduct indicates prior exposure to a potential carcinogen but does not by itself indicate the presence of cancer in the animal. Reynolds and Wetzel (2010) found elevated levels of PAHs in the livers of Cook Inlet beluga males, blubber of females, and in two fetuses. Thus far, necropsies on Cook Inlet belugas have not shown the high incidence of cancers that have been documented for the St. Lawrence Estuary population.

Concentrations of organochlorine and metal contaminants in baleen whales are low, and there is no firm evidence that levels of organochlorines, organotins, or heavy metals are high enough to cause toxic or other damaging effects (O'Shea and R. L. Brownell 1994). Baleen whales can accumulate lipophilic compounds (e.g., halogenated hydrocarbons) and pesticides (e.g., DDT) in their blubber as a result of feeding on contaminated prey or inhalation in areas of high contaminant concentrations (Barrie et al. 1992, Wania and Mackay 1993). Some contaminants may be passed on to young during gestation and lactation (Aguilar and Borell 1994). The health effects of different doses of contaminants on marine mammals are currently unknown; however, there is evidence of detrimental health effects from these compounds in other mammals, including disease susceptibility, neurotoxicity, and reproductive and immune system impairment (Reijnders 1986, de Swart et al. 1996, Eriksson, Jakobsson and Fredriksson 1998). Although there has been substantial research on the identification and quantification of such contaminants on individual whales, no detectable effect from contaminants has been identified in baleen whales. There may be chronic, sub-lethal impacts that are currently unknown.

Steller sea lions are exposed to local and system-wide contaminants and pollutants as they traverse the North Pacific basin. Effects on other pinnipeds have included acute mortality, reduced pregnancy rates, immuno-suppression, and reduced survival of first born pups (NMFS 2008b). There are no published reports of contaminants or pollutants, other than spilled oil, resulting in mortality of Steller sea lions (NMFS 2008b).

5.8 Fisheries

Cook Inlet supports several commercial fisheries, all of which require permits. Commercial fisheries are divided into the upper and lower Cook Inlet regions.[23] The upper region contains all waters north of Anchor Point and is further divided into the Northern (north of the West and East Foreland) and Central Districts (south of the Forelands to Anchor Point Light). Species

[23] http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareacookinlet.main Accessed May 2023.

commercially harvested in upper Cook Inlet include all five Pacific salmon species (drift and set gillnet), eulachon or smelt (dipnet), Pacific herring (gillnet), and razor clams (hand-digging). Sockeye salmon are the most economically valuable,[24] accounting for 91 percent of the total ex-vessel value over the past 10 years.[25]

The average annual commercial harvest of salmon in upper Cook Inlet from 1966-2016 was 3.5 million (Shields and Dupuis 2017). The most recent 10-year average annual commercial salmon fishery harvest is 2.5 million fish, and the 2022 harvest of 1.4 million was 44 percent less than the 10-year average. The 2022 upper Cook Inlet commercial harvest compared to the recent 10-year average was down 34 percent for chum, 43 percent for sockeye, 44 percent for coho, 58 percent for Chinook, and 72 percent for pink salmon. At this point, it is hard to know if these results are a short-term reflection of natural variation or are an indicator of a more systematic shift and downward trend. Salmon are the primary prey item for Cook Inlet beluga whale and these numbers may be a cause for concern; at best, they indicate there are fewer salmon available for commercial fisheries, recreational, personal and subsistence use, and beluga whales.

The North Pacific Fishery Management Council first developed the Salmon Fishery Management Plan (FMP) under the Magnuson-Stevens Act more than 40 years ago. It excluded designated federal waters in Cook Inlet, which allowed the State of Alaska to manage commercial salmon fishing in the area. Currently, there are no federal fishing regulations governing salmon fishing in the Federal waters of Cook Inlet. In the absence of federal regulations, the State of Alaska regulates state-permitted vessels when fishing for salmon in both the State and Federal waters of Cook Inlet. However, NMFS recently published a proposed rule amending the Salmon FMP, which would establish Federal fishery management for all salmon fishing that occurs in the Cook Inlet EEZ, including commercial drift gillnet and recreational salmon fishery sectors (88 FR 72324, Oct. 19, 2023).

Recreational fisheries exist in the river systems on the western Kenai Peninsula for salmon (Chinook, sockeye, pink, and coho), both freshwater and marine Dolly Varden char, and rainbow trout/steelhead trout. In the marine waters throughout Cook Inlet, recreational fishing occurs for salmon (Chinook and coho), Pacific cod, and halibut. Many of the charter fishing vessels targeting salmon and halibut operate out of Homer in lower Cook Inlet. A new recreational dipnet fishery on the Susitna River for all species other than Chinook salmon began in 2020.

Sport fishing for Chinook salmon in Cook Inlet salt waters was closed from May 15 through July 31, 2023.[26] In conjunction with this closure, additional emergency orders prohibited the retention of wild Chinook salmon in the Ninilchik and Kasilof Rivers and restricted other Chinook salmon fisheries in the Susitna River, Northern Cook Inlet, and West Cook Inlet areas. Based on escapement monitoring in the Kenai, Anchor, and Deshka Rivers, the Chinook salmon runs were forecast to be below the lower end of their escapement goals, which triggered the in-river sport fishery preseason closures in these streams. Additionally, all of these stocks failed to achieve

---

[24] http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareauci.main Accessed May 2023.
[25] https://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1447206643.pdf Accessed May 2023.
[26] https://www.adfg.alaska.gov/sf/EONR/index.cfm?ADFG=region.NR&Year=2023&NRID=3455 Accessed May 2023.

their escapement goals in 2022. The low productivity period was expected to continue for Cook Inlet Chinook salmon in 2023.

An important remaining unknown is the extent to which Cook Inlet marine mammal prey is made less available due to commercial, subsistence, personal use, and sport fishing either by direct removal of the prey or by human-caused habitat avoidance.

Potential impacts from commercial fishing on Cook Inlet beluga whales, humpback whales, and Steller sea lions include ship strikes, harassment, gear entanglement, reduction of prey, and displacement from important habitat. For example, the Kenai River is the most heavily-fished river in Alaska;[27] belugas no longer use waters near the river during salmon fishing season, despite the fact that it has the largest salmon run in Cook Inlet and was heavily used beluga foraging habitat in the past (Ovitz 2019).

5.8.1 Entanglement

Prior to the mid-1980s, there were only two reports of fatal takes of belugas incidental to entanglement in fishing gear in Cook Inlet (Murray and Fay 1979, Burns and Seaman 1986). There have been sporadic reports of single belugas entangled in fishing nets since then; however, the only confirmed mortality was a young Cook Inlet beluga carcass recovered from a subsistence set net in 2012. Non-lethal entanglements have been documented; in 2005, a beluga entangled in an unknown object, perhaps a tire rim or a culvert liner, was photographed in Eagle Bay (McGuire, Stephens and Bisson 2014), and another was repeatedly photographed in 2010–2013 with what appeared to be a rope entangled around the upper portion of its body near the pectoral flippers (McGuire, Stephens and Bisson 2014). It is unknown if these animals were able to disentangle themselves or if they died as a result of the entanglements (NMFS 2016b).

Humpback whales have been killed and injured during interactions with commercial fishing gear; however, the frequency of these interactions does not appear to have a significant adverse consequence for humpback whale populations. In Alaska, most humpbacks become entangled with gear between early June and early September while foraging in nearshore waters. A photographic study of humpback whales in Southeast Alaska found at least 53 percent of individuals showed some kind of scarring from fishing gear entanglement (Neilson et al. 2005).

Human-caused mortality and injury reported for humpback whales in Alaska from 2016 to 2020 was 65 animals, 47 of which were entanglements (Freed et al. 2022). In 2015, a humpback whale was entangled in a salmon purse seine net in Cook Inlet but was cut free by the fisherman, and was assumed to be unharmed (Delean et al. 2020). A minke whale or small humpback whale was reported entangled near the Lands End hotel in Homer in 2017, and a humpback whale was reported entangled near the Homer Spit in 2019 (NMFS unpublished data). These are the only known humpback whale entanglements in Cook Inlet.

ADFG analyzed data from 1,439 individually marked Steller sea lions that were re-sighted from 2001 through 2015, and found that animals that had ingested salmon hook and line fishing gear

[27] http://www.adfg.alaska.gov/index.cfm?adfg=ByAreaSouthcentralUpperKenai.fishingInfo Accessed May 2023.

had lower survival than comparable animals that had not ingested fishing gear (Freed et al. 2022). The minimum estimated mean annual mortality and serious injury rate in U.S. commercial fisheries between 2014 and 2018 was 37 Western DPS Steller sea lions, and this is likely an underestimate of the actual level (Muto et al. 2021). Between 2016 and 2020 human-caused mortality and injury of the Western DPS Steller sea lions (n = 148) was primarily caused by entanglement in fishing gear, in particular, commercial trawl gear (n=113; Freed et al. 2022). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries, and is a minimum because not all entangled animals strand nor are all stranded animals found, reported, or have the cause of death determined. Overall, the relative impact on the recovery of the Western DPS of Steller sea lion due to entanglement is ranked as low (NMFS 2008b).

5.8.2 Competition for Prey

Fisheries in Cook Inlet have varying likelihoods of competing with marine mammals for fish, depending on gear type, species fished, timing, and fisheries location and intensity. Cook Inlet beluga whales may experience reduced prey availability and/or habitat displacement due to commercial and recreational fishing activity. Watercraft operating near the mouths and deltas of rivers entering Cook Inlet, Turnagain Arm, and Knik Arm can deter beluga whales from pursuing eulachon and salmon prey in these waters. For example, belugas have not been observed in recent times in or near the Kenai River when salmon runs are strong and fishing activity is high; however, there are numerous reports of whales in the river before and after the summer salmon fishing season (Castellote et al. 2015, Shelden et al. 2015b).

Cook Inlet belugas are dependent on access to relatively dense concentrations of high value prey species, particularly in the spring and throughout the summer months. Norman (2011) estimated that 350 Cook Inlet beluga whales would consume a total biomass of approximately 1,250 metric tons of fish during the summer. Chum, coho, and other salmonid species constitute >54 percent of their summer diet (Hobbs and Shelden 2008). The 2022 upper Cook Inlet commercial salmon fishery harvest was 1.4 million fish, 44 percent less than the most recent 10-year average. A reduction in the amount of available prey could impact Cook Inlet beluga whale energetics and delay recovery.

The operation of watercraft near the mouths and deltas of rivers entering Cook Inlet, Turnagain Arm, and Knik Arm may result in beluga whale habitat displacement, if pursuit of eulachon and salmon prey in these waters is impeded. NMFS has numerous reports of beluga whales in the Kenai River prior to and after the summer salmon fishing season; however, the whales have not been observed in or near the river in recent times when salmon runs are strong and fishing activity is high (Castellote et al. 2015, Shelden et al. 2015b).

There has been considerable debate among the scientific community as to whether fisheries reduce Steller sea lion prey biomass and quality at local and/or regional spatial scales, which then leads to a reduction in Steller sea lion survival and reproduction (NMFS 2008b). The most recent minimum total annual direct mortality of Western DPS Steller sea lions associated with commercial fisheries is 37 individuals (Muto et al. 2021).

Important foraging areas for humpback whales are outside of Cook Inlet and prey competition is unlikely to occur.

5.9 Tourism

There are no commercial whale-watching companies operating in upper Cook Inlet. Aerial tours, such as guided hunting trips, may effect belugas by flying at low altitudes or circling the whales. NMFS has conducted outreach to local pilots and encouraged them to maintain an altitude of 1,500 feet or higher over belugas and to avoid circling over the animals.

Tourism continues to grow in lower Cook Inlet, and a number of commercial vessel-based tour companies operate primarily out of Homer. The tour vessels range in size and capacity from 6 to over 100 passengers, and include fishing and wildlife viewing tours. There are also a number of commercial flight-seeing tour operators based in Homer. Flights occur over land on the Kenai Peninsula, the waters of lower Cook Inlet (Kachemak Bay), and across the Inlet to places such as Katmai National Park and McNeil River State Game refuge. Aircraft have the potential to disturb marine mammals, particularly pinnipeds hauled out.

5.10 Direct Mortality

Within the proposed action area there are several potential sources of direct anthropogenic mortality, including shootings, strandings, fishery/gear/debris interactions, vessel collisions, predation, and research activities. NMFS is not aware of any illegal shootings of listed marine mammals in Cook Inlet (NMFS Alaska Regional Office Stranding Database accessed May 2023).

5.10.1 Subsistence Harvest

The ESA and MMPA allow for the harvest of marine mammal species by Alaska Natives for subsistence purposes and for creating and selling authentic native articles of handicrafts and clothing. Subsistence harvest of Western DPS Steller sea lions is regulated by co-management agreements with NMFS, and occurs at or well below sustainable levels of harvest. Annual statewide data on community subsistence harvest of Steller sea lions are no longer collected as of 2009; therefore, the best available statewide subsistence harvest estimates for Western DPS Steller sea lions are those from 2004 to 2008. The mean annual subsistence take (harvested plus struck-and-lost) from the Western DPS from 2004 through 2008, combined with the mean annual take between 2014-2018 from St. Paul, St. George, and Atka Island, was 209 sea lions per year (Muto et al. 2021).

Subsistence hunters in Alaska are not authorized to take humpback whales. However, one humpback whale was unlawfully harvested in Kotlik in October 2006, and another in Toksook Bay in May 2016.

Previous Cook Inlet beluga subsistence harvests have had a significant effect on the population. While an unknown amount of harvest occurred for decades or longer, the subsistence harvest increased substantially to unsustainable levels in the 1980s and 1990s. Harvests from 1994 to

1998 likely account for the population decline during that time period. Cook Inlet beluga whale subsistence harvest ceased in 1999 as a result of both a voluntary moratorium by the hunters, and passage of Public Law 106–31, section 3022 (later made permanent by Public Law 106-553, section 627), which required any taking of Cook Inlet beluga whales by Alaska Natives to occur pursuant to a cooperative agreement between NMFS and affected Alaska Native organizations. The law did not specify a harvest level or a harvest management plan. In May 2000, NMFS designated Cook Inlet belugas as a depleted stock under the MMPA (65 FR 34590, May 31, 2000). Subsequently, NMFS promulgated interim harvest regulations that provided a harvest management plan (69 FR 17973, April 6, 2004). The co-management agreement developed pursuant to these regulations allowed the harvest of two whales in 2005 and one whale in 2006; however, no whales were taken in 2006 due to poor weather and the avoidance of females with calves. In 2008, NMFS issued regulations (73 FR 60976, October 15, 2008; 50 CFR § 216.23(f)) establishing long-term limits on the maximum number of Cook Inlet beluga whales that may be taken for subsistence by Alaska Natives. These long-term harvest limits, developed for five-year intervals, require that the abundance estimates reach a minimum five-year average of 350 belugas (50 CFR 216.23(f)(2)(v)). No hunt has been authorized since 2006.

5.10.2 Poaching and Illegal Harassment

Due to their distribution within the most densely populated region in Alaska and their approachable nature, the potential for poaching beluga whales in Cook Inlet exists. NMFS maintains an enforcement presence in upper Cook Inlet; however, effective enforcement across such a large area is difficult. NMFS Enforcement has investigated several reports of Cook Inlet beluga whale harassment, but there have been no confirmed poaching incidents.

Historically, Steller sea lions have been poached and illegally harvested throughout their range. The NMFS Alaska Marine Mammal Stranding Program documented 60 Steller sea lions with suspected or confirmed firearm injuries in Southeast and Southcentral Alaska from 2000–2019 (Wright 2016, 2021). Western DPS Steller sea lions with gunshot wounds have been found stranded on shore along the outer Copper River Delta in recent years (Wright 2016, 2021), and seven of nine pinnipeds stranded in the surveyed area in 2019 were shot (Wright 2021).

Few illegal harvests of humpback whales have occurred in Alaska (there are two known cases). Subsistence hunters in western Alaska incorrectly believed they could legally harvest large whales other than bowheads (e.g., humpback, gray, and minke whales).

5.10.3 Stranding

Cook Inlet beluga whales are likely predisposed to stranding because they breed, feed, and molt in the shallow waters of upper Cook Inlet where extreme tidal fluctuations occur. Strandings may be intentional (e.g., to avoid killer whale predation), accidental (e.g., chasing prey into shallows then becoming trapped by receding tide), or a result of injury, illness, or death. Stranding events that last more than a few hours may result in mortalities. An estimated 876 to 953 live beluga strandings and 214 dead beluga beachings have been documented in Cook Inlet from 1988 through 2015 (NMFS 2016b). Patterns of mortality for the population were analyzed and live stranding was the predominant assigned cause of death; however, this only represented approximately 33 percent of the deaths of known cause (McGuire et al. 2021). Causal factors for the majority of deaths and live strandings are unknown.

An unusually high number of beluga live stranding events occurred in Turnagain Arm in 2003 (Vos and Shelden 2005). The number of animals stranded ranged from 2 to 46 and led to 5 confirmed deaths (Vos and Shelden 2005). Stranding is a stressful event and, if the beluga survives, health after the event may be affected. Stranding events may represent a significant threat to the conservation and recovery of this population.

Live strandings are uncommon among sea lions; however, pinniped strandings and mortality resulting from entanglement in fishing gear have been documented (Loughlin and York 2000, Raum-Suryan, Jemison and Pitcher 2009, Muto et al. 2021).

Nearly all known cases of humpback whale strandings involve animals that died at sea of various other causes and washed ashore. A young humpback live stranded on the mud in Turnagain Arm in April 2019 and, while it freed itself on an incoming tide at one point, the whale later died.

5.10.4 Predation

Killer whales are the only natural predators of beluga whales, Steller sea lions, and humpback whales in Cook Inlet (Muto et al. 2021). Killer whale sightings were not well-documented prior to the mid-1980s and were likely rare in the upper Inlet. Alaska Native beluga hunters reported that killer whales were rarely seen in the upper Inlet or near belugas (Huntington 2000). Sightings from systematic surveys, observer databases, and anecdotal accounts from 1975 to 2002 were compiled and there were only 18 documented sightings north of Kalgin Island (Shelden et al. 2003). Killer whales were not observed in upper Cook Inlet during approximately 4,000 hours of land- and vessel-based surveys conducted from 2005 to 2017, and there were no scars consistent with killer whale attacks in the photographs taken during these surveys (McGuire et al. 2020). Monitoring efforts during the POA PCT construction project (2020-2021) detected two transient killer whales in Knik Arm in September 2021. Two to three killer whales were observed in close proximity to belugas in Knik Arm near Cairn Point on September 27, 2023.

Prior to 2000, it was estimated that an average of one Cook Inlet beluga whale was killed annually by killer whales (Shelden et al. 2003). From 1982-2014, between 9 and 12 beluga whale deaths were suspected to be a direct result of killer whale predation (NMFS 2016b). From 2011 through 2020, NMFS received no reports of possible predation attempts in upper Cook Inlet.

Predation may potentially have a significant impact on the Cook Inlet beluga whale population (Shelden et al. 2003). Killer whale predation of belugas is likely underestimated, as remains of preyed-upon belugas may sink and go undetected by humans. Beluga whale stranding events have also been correlated with killer whale presence; Native hunters report that beluga whales intentionally strand themselves in order to escape killer whale predation (Huntington 2000). However, the very low number of killer whale sightings or acoustical detections in the upper Inlet over the last 20 years indicate that the threat may be less than initially hypothesized or may have been greater when the beluga population was more robust. The contraction of Cook Inlet beluga summer range to the shallow waters of the upper Inlet may also reduce the opportunity for killer whales to pursue belugas (NMFS 2016b).

The risk to Western DPS Steller sea lions from killer whale predation is considered potentially high (Muto et al. 2021), and may be one of the causes contributing to population declines in areas outside of Cook Inlet (Barrett-Lennard et al. 1995). An unsuccessful killer whale attack on a humpback whale was recorded in lower Cook Inlet in 2008 (Matkin 2011). The numbers of Steller sea lions and humpback whales are very low in Cook Inlet and any isolated predation event that may occur would not have a population level effect.

5.10.5 Vessel Strikes

Cook Inlet beluga whales are susceptible to vessel strike mortality. In an examination of 106 individuals, 37.7 percent had scars classified as either confirmed or from possible anthropogenic origin; 14 percent had signs of confirmed or possible vessel strike (McGuire et al. 2020).

Beluga whales may be more susceptible to strikes from commercial and recreational fishing vessels (as opposed to cargo ships, oil tankers, and barges) because both belugas and fishing activities occur where salmon and eulachon congregate. A number of beluga whales have been photographed with propeller scars (McGuire, Stephens and Bisson 2014), suggesting that small vessel strikes are not rare, but such strikes are often survivable. Small boats are able to quickly approach and disturb these whales in their preferred shallow coastal habitat. Vessel strike and the resultant injury or death continue to be a threat to Cook Inlet beluga whales.

Although risk of vessel strike has not been identified as a significant concern for Steller sea lions, the recovery plan for this species states that Steller sea lions may be more susceptible to ship strike mortality or injury in harbors or in areas where animals are concentrated, e.g., near rookeries or haulouts (NMFS 2008b). In 2007, a Steller sea lion with two separate wounds consistent with blunt trauma that may have been from a vessel strike was found in Kachemak Bay (NMFS Alaska Regional Office Stranding Database accessed May 2023). A vessel strike of a Steller sea lion is highly unlikely to occur due to their maneuverability, very low numbers in upper Cook Inlet, and the slow vessel speeds in and around the POA.

From 1978-2011, there were at least 108 recorded whale-vessel collisions in Alaska, with the majority occurring in Southeast Alaska (Neilson et al. 2012). Between 2013 and 2017, 29 humpback whales were struck, resulting in 11.92 mortalities or serious injuries in Alaska (Delean et al. 2020). Eighteen humpback whales were struck in Alaska, resulting in 9.66 mortalities or serious injuries between 2016 and 2020 (Freed et al. 2022). Among larger whales, humpback whales are the most frequent victims of ship strikes in Alaska, accounting for 86 percent of all reported collisions (Neilson et al. 2012). There have been three documented large cetacean vessel collisions in Cook Inlet since 2001; one humpback whale, one fin whale, and one unidentified large cetacean. In 2001, a humpback whale was discovered on the bulbous bow of a 710-foot container ship as it docked in the POA; where the vessel may have collided with the whale is unknown. In 2005, a 28-foot charter boat hit an unidentified large cetacean (NMFS Alaska Regional Office Stranding Database accessed May 2023). In 2015, a dead fin whale was discovered at the POA on the bulbous bow of a ship traveling from Seattle; it is unknown where the strike occurred (NMFS Alaska Regional Office Stranding Database accessed May 2023). The very low number of humpback whales in upper Cook Inlet greatly reduces the probability of vessel strike in this area.

5.10.6 Research

Research often assists in the recovery of threatened and endangered species; however, research activities may also disturb, harm, or kill the studied animal. Marine mammal research often requires the use of boats, which adds to vessel traffic, sound, and pollution in the area. Boat-based surveys, such as photo-identification studies, often require the boat to closely approach whales or whale groups. Deployment and retrieval of passive acoustic monitoring devices requires a boat, which temporarily increases noise in the immediate area. However, once the instruments are deployed, passive acoustic monitoring is noninvasive. Aerial surveys may also disturb whales, especially when circling at low-altitudes to obtain accurate group counts.

Scientific research and enhancement permits that authorize take of ESA listed marine mammals are issued as joint permits under section 104 of the MMPA and section 10(a)(1)(A) of the ESA. From 2017 through 2021, 11 MMPA/ESA research and enhancement permits authorized take of Cook Inlet beluga whales. In 2019, the Office of Protected Resources completed a programmatic biological opinion, which analyzed research impacts on endangered cetaceans; proposed research efforts on endangered or threatened cetacean populations were thought unlikely to cause a change in abundance or reproduction (NMFS 2019a).

More invasive research activities include animal capture, collecting blood and tissue samples, and attaching tracking devices such as satellite tags. Between 1999 and 2002, NMFS placed satellite tags on 18 beluga whales in upper Cook Inlet (Hobbs et al. 2005). In 2002, a tagged beluga was found dead 32 hours after being tagged. Another two tagged beluga whales, with similar dive patterns and tagged in the same manner as the deceased whale, transmitted data for less than 48 hours; it is unknown if these whales also perished or were fitted with defective tags (NMFS, unpublished data).

The Cook Inlet beluga whale photo identification project, started in 2005, identified many of the tagged belugas; 5 of the 14 tagged whales in the photo-id catalog had visible signs of tag-site infection, 8 had signs of concavity of the dorsal crest above the tag site, and 2 showed damage to the left pectoral fins, likely caused by flipper bands applied during tagging (McGuire and Stephens 2016). In 2015, a previously tagged whale washed up dead with a significant infection at the tag attachment site, potentially the cause of death. Another whale photographed with serious infection at the tag site has not been documented since 2007 (McGuire and Stephens 2016). The satellite tags provided data on the movement within Cook Inlet and dive behavior (Shelden et al. 2018); however, it is unlikely that this type of project will be repeated. Research will continue but will focus on minimally invasive research techniques.

It has been suggested that an increase in the authorized number of Cook Inlet beluga whale takes projected to occur through 2025 is statistically correlated with the decreasing population size (Migura and Bollini 2022). However, 99 percent of the total authorized take in any year are for non-invasive methods, such as photo-identification during vessel surveys. When permitted researchers approach animals closer than the NMFS wildlife viewing guideline distances,[28] it is counted as a "take" because those animals may be harassed by the activities. The potential impacts from these research methods are ephemeral harassment at worst. The programmatic biological opinion prepared for NMFS' cetacean research and enhancement permitting program (NMFS 2019a) mentioned above, determined that these methods (e.g., aerial and vessel surveys) are not likely to adversely affect any ESA-listed populations or species, including Cook Inlet beluga whales.

The number of authorized research takes is typically significantly larger than the number of actual takes that occur. For example, 22,090 takes were authorized for Cook Inlet beluga research occurring in 2019; 2,405 takes mostly by harassment occurred. Managers have simplified how take numbers in research permits are determined, in order to provide a more consistent approach to counting take across incidental and directed take permitting programs. NMFS Permits Division continues to closely analyze the number of takes requested and used by researchers each year.

In addition to research activities involving free-ranging Cook Inlet belugas, a single whale is housed in captivity. "Tyonek" live-stranded near Trading Bay as a young calf in 2017. The Alaska Sealife Center and partners provided rehabilitative care; however, the animal was determined to be non-releasable due to underlying medical problems. Pursuant to a scientific research and enhancement permit, which includes an educational component, Tyonek is permanently located at SeaWorld San Antonio, Texas. This is a unique incident, and there are no plans to house additional Cook Inlet beluga whales in captivity.

With the low occurrence of humpback whales and Steller sea lions in upper Cook Inlet, this area is not a high priority for research of these species. However, they may be indirectly affected or harassed by other non-invasive research projects, such as the Cook Inlet beluga aerial surveys. Aircraft may disturb Steller sea lions, especially if hauled out. Disturbance of a rookery or haulout has the potential to result in serious injury or death, predominantly from trampling. However, there are no rookeries or haulouts within Cook Inlet, and NMFS has no knowledge of any stampedes associated with research in the action area. Also, there have been no known instances of research-related deaths of humpbacks in the action area.

5.11 Climate and Environmental Change

The impacts of climate change are especially pronounced at high latitudes and in polar regions. Average temperatures have increased across Alaska at more than twice the rate of the rest of the United States.[29] In the past 60 years, average air temperatures across Alaska have increased by approximately 3°F, and winter temperatures have increased by 6°F (Chapin et al. 2014). Some of the most pronounced effects of climate change in Alaska include disappearing sea ice, shrinking glaciers, thawing permafrost, and changing ocean temperatures and chemistry (Chapin et al. 2014). Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems

[28] https://www.fisheries.noaa.gov/topic/marine-life-viewing-guidelines/guidelines-&-distances Accessed May 2023.
[29] https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-alaska_.html Accessed May 2023.

in the foreseeable future (Houghton 2001, McCarthy et al. 2001). The impacts of these changes and their interactions on listed species in Alaska are hard to predict.

Indirect threats associated with climate change include increased human activity as a result of regional warming. Less ice could mean increased vessel activity or construction activities with an associated increase in sound, pollution, and risk of ship strike. Human fishing pressure could change the abundance, seasonality, or composition of prey species. Fisheries in Alaska are managed with the goal of sustainability; however, not all fish stocks are assessed, and it is unknown whether management of fisheries for optimal returns provides sufficient densities in feeding areas for efficient foraging by ESA-listed marine mammal species.

Cook Inlet beluga whales likely rely on the combined salmon escapement from multiple watersheds. Changes in prey availability to belugas may result from changes in the total availability, quality, species composition, and seasonality of prey. The greatest climate change risks may be potential changes in salmon and eulachon abundance. These changes could occur through regime shifts and changes in ocean ecosystems and/or through changes in these species' freshwater habitat. Temperature and hydrology control several critical stages in the life cycle of salmonids in their freshwater habitats. During periods of rapid climate change, these can have significant effects on anadromous salmonid populations (Bryant 2009).

Temperature is the most important abiotic factor influencing the physiology of fishes and the pathogenicity of their disease organisms (Brett 1971, Marcogliese 2001). Fish are particularly vulnerable to mortality during periods of increased water temperatures, and mortality may occur through several mechanisms, including increased virulence of pathogens, increases in metabolic rate that outstrip energy resources, and an oxygen demand that exceeds the heart's capacity to deliver oxygen (von Biela et al. 2020). Stream temperatures are closely related to air temperatures (Mohseni and Stefan 1999), and the annual surface air temperatures (north of 60° N) from October 2021-September 2022 were the sixth warmest dating back to 1900.[30] Surface air temperatures were 33°F warmer than the 1991-2020 mean, continuing the common, recent pattern where annual temperatures have both exceeded the 30-year Arctic mean and been warmer than the global mean.

In June and July 2019, air temperatures over much of Alaska and the southern Yukon Territory reached record highs[31] and salmon dying before they could spawn were recorded in the Yukon River (von Biela et al. 2020), the Koyukuk River (Westley 2020), the Igushik River (a tributary to Bristol Bay where it was estimated that a minimum of 100,000 salmon died),[32] and the Kuskokwim River.[33] The parasites *Ichthyophonus* (a protozoan) and *Henneguya* (a cnidarian), which cause tapioca disease were prevalent in the salmon from the Kuskokwim. Pre-spawning mortality has also been documented in several Pacific Northwest watersheds, including the

[30] https://arctic.noaa.gov/Report-Card/Report-Card-2022/ArtMID/8054/ArticleID/992/Surface-Air-Temperature Accessed May 2023.
[31] https://www.ncei.noaa.gov/news/national-climate-201912 Accessed May 2023.
[32] https://alaskapublic.org/2020/01/15/in-some-bristol-bay-rivers-the-hottest-month-on-record-was-deadly-for-salmon/ Accessed May 2023.
[33] https://www.kyuk.org/hunting-fishing/2019-07-12/record-warm-water-likely-gave-kuskokwim-salmon-heart-attacks Accessed May 2023.

Fraser River in British Columbia (Hinch et al. 2012, Martins et al. 2012) and streams in the Lake Washington Basin in Washington (Barnett et al. 2020). The warming conditions during migration and spawning, in concert with other factors such as infections with pathogens, were responsible for the increased pre-spawning mortality of adult sockeye salmon, and were high enough to threaten the viability of the population (Barnett et al. 2020).

Mauger et al. (2017) monitored temperatures in 48 non-glacial streams across the Cook Inlet basin during open-water periods from 2008 to 2012 and found that numerous watersheds exceeded maximum weekly maximum temperature (MWMT) threshold ranges for the protection of salmon life stages. MWMT at most sites exceeded the established criterion for spawning and incubation during every year of the study, which suggests salmon are experiencing thermal stress in the Cook Inlet region (Mauger et al. 2017). The Deshka River, an important tributary to the Susitna River, had MWMT temperatures above 64°F during four years of the study period and above 68°F for three years (Mauger et al. 2017). As stream temperatures increase in response to increasing air temperatures, critical thresholds will likely be exceeded more often, especially when warm air temperature anomalies occur.

Population modeling linked Cook Inlet beluga reproductive success with salmon abundance in the Deshka River (Norman et al. 2020). Simulations showed that if salmon runs remained at their current levels, the Cook Inlet beluga whale population would likely continue its current slow decline and per capita births would continue to be low. However, Cook Inlet beluga whales forage at several streams throughout the summer and likely rely on the combined escapement from multiple watersheds. The concept of food resources limiting a cetacean population is not new though, and reduced prey availability (Chinook salmon) has been directly linked to increased mortality and reduced health and survival of the Southern Resident killer whale population (Ward, Holmes and Balcomb 2009, Wasser et al. 2017).

In summary, the effects of climate change will likely impact Cook Inlet beluga whales, primarily through their primary prey species, salmon. Warmer ocean temperatures, warmer stream temperatures, and warmer air temperatures will likely lead to many challenges and changes to the freshwater and marine ecosystems that salmon depend on. Pre-spawning salmon mortalities, reductions in returns, and shifts in run timing have already been documented. It remains to be seen how adaptable both salmon and belugas can be in the face of rapidly changing conditions.

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

An Unusual Mortality Event (UME) of large cetaceans occurred in Alaska waters in 2015-2016. Reports of dead whales included 22 humpback, 12 fin, 2 gray, 1 sperm, and 6 unidentified whales. There was an unusually large number of dead whales found in British Columbia during this time as well. The strandings were concurrent with the arrival of the Pacific marine heatwave, one of the strongest El Nino weather patterns on record, decreasing ice extent in the Bering Sea, and one of the warmest years on record in Alaska in terms of air temperature.

Recent studies and observations have shown changes in distribution (Brower, Clarke and Ferguson 2018), body condition (Neilson and Gabriele 2020), and migratory patterns of humpback whales, likely in response to climate change. The indirect effects of climate change on humpback whales over time would likely include changes in the distribution of ocean temperatures suitable for many stages of their life history, the distribution and abundance of prey, and the distribution and abundance of competitors or predators.

The Pacific marine heatwave is also likely responsible for poor growth and survival of Pacific cod, an important prey species for Steller sea lions. The 2018 Pacific cod stock assessment estimated that the female spawning biomass of Pacific cod was at its lowest point in the 41-year time series considered. This assessment was conducted following three years of poor recruitment and increased natural mortality during the Gulf of Alaska marine heat wave from 2014 to 2016 (NMFS 2018a).

The Steller Sea Lion Recovery Plan ranks environmental variability as a potentially high threat to recovery of the Western DPS (NMFS 2008b). The Bering Sea and Gulf of Alaska are subjected to large-scale forcing mechanisms that can lead to basin-wide shifts in the marine ecosystem resulting in significant changes to physical and biological characteristics, including sea surface temperature, salinity, and sea ice extent and amount.

Physical forcing affects food availability and can change the structure of trophic relationships by impacting climate conditions that influence reproduction, survival, distribution, and predator-prey relationships at all trophic levels. Warmer waters could favor productivity of some species of forage fish, but the impact on recruitment of important prey fish of Steller sea lions is unpredictable. Recruitment of large year-classes of gadids (e.g., pollock) and herring has occurred more often in warm than cool years, but the distribution and recruitment of other fish (e.g., osmerids) could be negatively affected (NMFS 2008b). Populations of Steller sea lions in the Gulf of Alaska and Bering Sea have experienced large fluctuations due to environmental and anthropogenic forcing (Mueter et al. 2009).

5.12 Environmental Baseline Summary

While the majority of Cook Inlet is undeveloped, upper Cook Inlet is exposed to more anthropogenic activities than most other locations in Alaska. The existing anthropogenic and natural activities described above (e.g., coastal development, oil and gas development, fisheries, climate change) are expected to continue. Listed species and/or critical habitat in the action area may be impacted by one or more of these risk factors.

The Cook Inlet beluga population experienced a declining trend of 2.3 percent per year from

2008 to 2018. The population trend is unknown for both the Mexico and WNP DPS of humpback whales. Western DPS Steller sea lion numbers within Southcentral Alaska also appear to be stable or increasing. Although we do not have information on other measures of the demographic status of Steller sea lions (for example, age structure, sex ratios, or the distribution of reproductive success) that would facilitate a more robust assessment of the probable impact of factors discussed in the Environmental Baseline,[34] we infer from their increasing abundance in the vicinity of Cook Inlet that no factor alone or in combination is preventing this population from increasing in this area.

The main threats to recovery of Mexico and WNP DPS humpback whales is thought to be entanglement in fishing gear and vessel strike due to increased shipping throughout their range (Young et al. 2023). These threats are discussed in this Environmental Baseline, but do not appear to be significant stressors in Cook Inlet.

The cause, or causes, of the continued decline of Cook Inlet beluga whales is unknown. The Recovery Plan (NMFS 2016b) outlines multiple threats to Cook Inlet beluga whales. Many of the projects and issues discussed in this Environmental Baseline are specific examples of these types of threats (e.g., sound, habitat loss or degradation, pollution, cumulative effects, etc.).

6. EFFECTS OF THE ACTION

"Effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR § 402.02).

This biological opinion relies on the best scientific and commercial information available. We try to note areas of uncertainty, or situations where data is not available. In analyzing the effects of the action, NMFS aims to minimize the likelihood of false negative conclusions (i.e., 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

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

action poses to endangered and threatened species.

NMFS identified and addressed all potential stressors, and considered all consequences of the proposed action, individually and cumulatively, in developing the analysis and conclusions in this opinion regarding the effects of the proposed action on ESA-listed species and designated critical habitat.

6.1 Project Stressors

Stressors are any physical, chemical or biological phenomena that can induce an adverse response. The effects section starts with identification of the stressors produced by the constituent parts of the proposed action. Based on our review of the data available, the POA NES1 project may cause the following stressors:

- Acoustic disturbance from non-pile driving construction activities
- Vessel noise, presence, and strikes
- Sea floor disturbance and turbidity
- Effects on prey
- Trash and debris
- Pollutants and contaminants
- Acoustic disturbance from pile driving and removal

6.1.1 Minor Stressors on ESA-Listed Species and Critical Habitat

Based on a review of available information, we determined the following stressors are either unlikely to occur or likely to have minimal impacts on Cook Inlet beluga whales, Mexico and WNP DPS humpback whales, and Western DPS Steller sea lions.

6.1.1.1 Acoustic disturbance from non-pile driving activities

Dredging will likely be performed 24 hours per day by two barges to remove approximately 1.35 million CY of fill material. During mechanical dredging (i.e., bucket dredge), an open bucket is lowered through the water column, closed after impact on the bottom, raised out of the water, and emptied into an adjacent barge. The maximum noise spike occurs when the bucket hits the bottom.

Marine mammal responses to dredging sounds may include avoidance, temporary change in swimming speed, change in swimming direction, altered breathing pattern, temporary heightened vigilance, temporary sound masking and/or reduced vocalization rate. A startle response would be unlikely as a dredge vessel is relatively stationary when dredging.

Anchored dredging and disposal activities have introduced continuous sounds into the water near the Anchorage Harbor since the 1960s. Belugas continue to use lower Knik Arm and are known to travel within 100 m of the POA, although they may alter their travel patterns to increase the distance to a noise source (Kendall and Cornick 2015). The regular presence of belugas around the POA could suggest a level of habituation to noise and activities in that area. However, belugas may also tolerate noise that would otherwise disturb them in order to reach feeding areas or to conduct other biologically significant behaviors. Steller sea lions are considered uncommon and humpback whales are considered rare in the action area. These species could be exposed to dredging noise but it is unlikely that an individual would be displaced from the area, and any disturbance would be limited in space and time. To minimize the risk of exposing listed species to acoustic stressors associated with dredging activities, the POA will implement a 50 m shutdown zone for belugas and a 10 m shutdown zone for Steller sea lions and humpback whales.

Based on the low intensity and stationary nature of the sounds produced by dredging, its perennial presence over many years in the same general location near the project site, and the implementation of mitigation measures, NMFS concludes that adverse effects to Cook Inlet beluga whales, Mexico or WNP DPS humpback whales, or Western DPS Steller sea lions are extremely unlikely to occur.

If sheet piles cannot be removed after excavation and dredging through direct pulling or use of a vibratory hammer to pull, or through use of a splitter to create vertical panels that can be pulled out, it will be necessary to remove them by cutting. Pile cutting will take place in the air, when feasible. Sounds produced by hydraulic shears cutting in-water are expected to be brief, low level, and intermittent, imparting minimal sound energy into the water column. The ultrathermic cutting process does not impart sound energy into the water, and instead relies on the application of heat to sever metal by melting. NMFS is unaware of any hydroacoustic measurements for underwater hydraulic shearing and underwater ultrathermic cutting. The POA will implement a 100 m shutdown zone for all marine mammals when hydraulic shears or ultrathermic cutting torches are in use.

In consideration of the mitigation measures to be implemented and the low likelihood of exposure above the 120 dB harassment threshold, impacts to ESA-listed species from the use of sheet pile cutting tools are expected to be undetectable and minor.

6.1.1.2 Vessel Noise, Presence, and Strikes

As described in the proposed activities, the project will use tugs and floating barges. Movement of project vessels will be localized within the vicinity of the POA, and the proposed action is not expected to increase the number of vessels that transit to and from the POA.

Auditory or visual disturbance to listed species could occur during vessel activities associated with the project. 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 and presence, 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. 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.

Behavioral responses of beluga whales to vessels include changing swimming direction, increasing swim speed, altering diving, surfacing, and breathing patterns, and changes in vocalizations (Wartzok et al. 2003). Past experiences with vessels, age, and activity during the vessel encounter appear to be important factors when considering the response of an animal (Wartzok et al. 2003, McQuinn et al. 2011). Older animals respond more often than younger animals, and belugas respond less often when engaged in feeding or traveling than during other activities. However, when whales did respond, the response was typically more pronounced (Fish and Vania 1971, Stewart, Evans and Awbrey 1982, Blane and Jaakson 1994).

Belugas have been found to change their vocalization frequency and intensity in response to noise in their environment (Au et al. 1985). Cetaceans, including belugas, have also been documented altering their calling rates and duration in noisy environments (Finley et al. 1990, Wright et al. 2007, Dunlop, Cato and Noad 2014, Erbe, Dunlop and Dolman 2018). In the St. Lawrence River, vessel noise affected beluga vocalizations with changes observed in calling rates, repetition of calls, increase in call duration, and upward shift in frequency (Lesage et al. 1999, Scheifele et al. 2005). Vocal responses were more persistent when whales were exposed to noise from a ferry compared to a small motorboat (Lesage et al. 1999). Repetition of calls in high Arctic belugas has been reported to be an alarm response (Sjare and Smith 1986, Finley et al. 1990).

Ship strikes can cause major wounds or death to marine mammals. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or a vessel propeller could injure or kill an animal below the water surface. Ship strikes of smaller cetaceans are less common than large whales, possibly due to their size and more agile nature. Cook Inlet beluga whales have been photographed with propeller scars (McGuire, Stephens and Bisson 2014). Individual belugas photographed between 2005 and 2017, along with stranding records, were examined to determine prevalence of scars indicative of anthropogenic trauma (McGuire et al. 2020). Out of 78 whales examined, 14 percent had signs of confirmed or possible vessel strikes. Vessel strikes of belugas have also been documented in the St. Lawrence River Estuary (Lair, Measures and Martineau 2015). Smaller boats traveling at higher speeds with frequent changes in direction frequently present a greater threat than larger, slower vessels moving in straight lines.

There are only four records of stranded Steller sea lions with injuries indicative of vessel strike in Alaska; three occurred in Sitka and one in Kachemak Bay (NMFS Alaska Regional Office Stranding Database accessed June 2023). Steller sea lions are likely more susceptible to ship strike mortality or injury in harbors or in areas where animals are concentrated, e.g., near rookeries or haulouts (NMFS 2008b). The risk of vessel strike, however, has not been identified as a significant concern for Steller sea lions. Steller sea lions are not concentrated in any locations near the POA.

From 1978-2011, there were 108 recorded whale-vessel collisions in Alaska, with the majority occurring in Southeast Alaska between May and September (Neilson et al. 2012). Small recreational vessels traveling at speeds over 13 knots were most commonly involved in ship strike encounters; however, all types and sizes of vessels were reported (Neilson et al. 2012). The majority of vessel strikes involved humpback whales (86 percent) and the number of humpback strikes increased annually by 5.8 percent from 1978 to 2011. Seventeen humpback whales were reported struck by vessels between 2013 and 2015 (Delean et al. 2020), and 18 humpbacks were reported struck by vessels between 2016 and 2020 (Freed et al. 2022) in Alaskan waters. There have been two reported ship strikes of unidentified large cetaceans in Kachemak Bay, lower Cook Inlet between 2000 and 2021 (NMFS Alaska Regional Office Stranding Database accessed June 2023). Humpback whales are rarely observed in the action area and the POA will implement a 100-m shutdown zone around moving vessels for ESA-listed species. This will minimize the risk of collision for humpbacks that may be present in the action area.

A very small proportion of primary prey species for listed marine mammals may be temporarily disturbed due to vessel effects (e.g., boat wakes, spinning propellers), such as exhibiting a startled or flight response (Popper and Hawkins 2019). These forms of disturbance would be temporary, with a geographic extent much smaller than the project action area. The risk of vessels striking prey species exists, but vessels will be operating at slow enough speeds for the prey to avoid collisions.

Based on the localized vessel activity, slow speeds, implementation of mitigation measures, and the rarity of collisions with marine mammals in Cook Inlet, NMFS concludes that adverse effects to Cook Inlet beluga whales, Mexico or WNP DPS humpback whales, or Western DPS Steller sea lions are extremely unlikely to occur.

6.1.1.3 Sea Floor Disturbance and Turbidity

The NES1 project will remove the failed sheet pile structure and impounded fill, restoring approximately 13 acres of subtidal and intertidal habitat lost when the structure was built in 2005–2011. The project area has not been considered to be high-quality habitat for marine mammals or marine mammal prey; however, removal of the North Extension bulkhead will create a permanent increase in available habitat for both marine mammals and fish.

Pile driving activity may temporarily increase turbidity. In general, turbidity associated with pile installation is localized to about a 7.6 m radius around the pile (Everitt, Fiscus and DeLong 1980), and the POA must comply with state water quality standards during these operations by limiting the extent of turbidity to the immediate project area. Shutdown mitigation measures are likely to prevent cetaceans from being close enough to experience effects of turbidity from pile driving, and pinnipeds could avoid localized areas of turbidity. The disposal of dredged material is expected to be intermittent, with a period of hours or days between barge disposal events, and disposal will not occur at night. Depending on the tides, turbidity levels from suspended sediments are expected to return to background levels in durations of 18 minutes to 3 hours.

Increases in turbidity will be temporary, localized, and difficult to detect in waters that have a very high concentration of suspended solids because of glacial runoff and extreme tidal exchange. Impacts on zooplankton, fish, and marine mammals are expected to be brief, intermittent, and minor, if impacts occur at all. Any effects to ESA-listed species from seafloor disturbance and increased turbidity levels would be immeasurably small.

6.1.1.4 Effects on Prey

Fish react to sounds that are especially strong and/or intermittent low-frequency sounds. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. Hastings and Popper (2005) identified several studies that suggest fish may relocate to avoid certain areas of sound energy.

Construction activities will produce non-impulsive (i.e., vibratory pile driving) and impulsive (i.e., impact pile driving) sounds. Impulsive sounds at received levels of 160 dB may cause subtle changes in fish behavior. SPLs of 180 dB may cause noticeable changes in behavior (Pearson, Skalski and Malme 1992, Skalski, Pearson and Malme 1992). SPLs of sufficient strength have been known to cause injury to, and mortality of fish (Popper et al. 2014). Pile driving associated barotrauma (i.e., damage to internal tissues) of fish has been found to occur at sound pressure levels of 205-215 dB re: 1 μPa_{peak} in experimental studies (Casper et al. 2012, Halvorsen et al. 2012). However, there are very few experimental examples of sound being sufficiently loud to result in death or mortal injury to fishes (Popper and Hawkins 2019).

Injury to fish depends more on the magnitude of particle motion than on sound levels as mammals perceive it (Popper and Hawkins 2019). It is likely that fish will avoid sound sources within ranges that may be harmful (McCauley, Fewtrell and Popper 2003). The most likely impact to fish from pile driving activities at the project area would be temporary behavioral avoidance of the area. The duration of fish avoidance of this area after pile driving ceases is unknown, but a rapid return to normal recruitment, distribution, and behavior is expected.

In general, impacts to marine mammal prey species are expected to be minor and temporary, given the small area of pile driving relative to known feeding areas of listed marine mammals. We expect fish will be capable of moving away from project activities to avoid exposure to noise. Any behavioral avoidance by fish of the disturbed area would still leave significantly large areas of fish and marine mammal foraging habitat in the nearby vicinity. We expect the area in which stress, injury, TTS, or changes in balance of prey species may occur will be limited to a few meters directly around the pile driving operations. We consider potential adverse impacts to prey resources from construction activities in the action area to be immeasurably small.

Studies on euphausiids and copepods, two of the more abundant and biologically important groups of zooplankton, have documented some sensitivity of zooplankton to sound (Chu, Sze and Wong 1996, Wiese 1996); however, any effects of pile driving activities on zooplankton would be expected to be restricted to the area within a few feet or meters of the project and would likely be sub-lethal. Any mortality or impacts on zooplankton as a result of construction operations is immaterial as compared to the naturally occurring reproductive and mortality rates of these species.

Given the short daily duration of sound associated with individual pile driving events, the relatively small areas being affected, the localized response of prey species, and the rapid return of any temporarily displaced species, pile driving activities are unlikely to have a permanent adverse effect on any prey habitat or prey species. Any impacts to marine mammal prey species are not expected to result in significant or long-term consequences for individual marine mammals, or to contribute to adverse impacts on their populations.

Based on the above information, prey species may respond to noise associated with the proposed action by avoiding the immediate area. However, the expected impact of project activities on marine mammal prey is very minor, and thus adverse effects to Cook Inlet beluga whales, Mexico and WNP DPS humpback whales, and western DPS Steller sea lions will be immeasurably small.

6.1.1.5 Trash and Debris

The NES1 project may generate trash comprised of paper, plastic, wood, glass, and metal from construction activities. The possibility exists that trash and debris could be released into the marine environment. This type of trash and debris discharge can pose risks to marine mammals. The POA intends to comply with all applicable regulations, so the amount of project-generated trash and debris is expected to be minimal or non-existent. The expected impact of trash and debris is very minor, and thus adverse effects to ESA-listed species will be immeasurably small.

6.1.1.6 Pollutants and Contaminants

Marine mammals could be exposed to authorized discharges through project vessels. 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 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 species or adversely modify designated or proposed critical habitat. An ESA consultation was completed for this general permit, impacts associated with marine vessel discharges were considered, and incidental take has been accounted for.

Accidental spills could occur from a vessel leak or onboard spill. The size of the spill influences the number of individuals that will be exposed and the duration of that exposure. Contact through the skin, eyes, or inhalation and ingestion could result in temporary irritation or long-term endocrine or reproductive impacts, depending on the duration of exposure. The greatest threat to cetaceans is likely from inhalation of volatile toxic hydrocarbon fractions of fresh oil, which can damage the respiratory system (Hansen 1985, Neff 1990), cause neurological disorders or liver damage (Geraci and St. Aubin 1990), have anesthetic effects (Neff 1990), and cause death (Geraci and St. Aubin 1990). However, toxic fumes from small spills are expected to rapidly dissipate into the atmosphere as fresh refined oil ages quickly, limiting the potential exposure of whales.

Cook Inlet beluga whales have lower contaminant loads than other populations of belugas (Becker et al. 2000). An increase in polycyclic aromatic hydrocarbons (PAHs) from an accidental spill could cause adverse effects on Cook Inlet belugas. High levels of PAHs have been considered as a factor in illness and mortality among beluga whales in the Saint Lawrence Estuary (Martineau et al. 1994, Martineau et al. 2002); however, no definitive causal relationship has been demonstrated. Maternal exposure to crude oil during pregnancy may negatively impact the birth weight of young, and ingestion can decrease nutrient absorption (St. Aubin 1988). Decreased food absorption could be especially problematic for very young animals, those feeding seasonally, and those needing to develop large amounts of fat for survival.

Based on the localized nature of small spills, the relatively rapid weathering and dispersion, and the safeguards in place to avoid and minimize oil spills, NMFS concludes that exposure of Cook Inlet beluga whales, humpback whales, Steller sea lions, or their prey to a small oil spill is extremely unlikely to occur. If exposure were to occur, NMFS does not expect detectable responses from listed marine mammals due to the ephemeral nature of small, refined oil spills.

6.1.2 Major Stressors on ESA-Listed Species and Critical Habitat

The following sections analyze the stressors likely to adversely affect ESA-listed species due to underwater anthropogenic sound. Construction activities will produce non-impulsive (i.e., vibratory pile driving) and impulsive (i.e., impact pile driving) sounds. First we provide a brief explanation of the sound measurements and acoustic thresholds used in the discussions of acoustic effects in this opinion.

6.1.2.1 Acoustic Thresholds

Since 1997, NMFS has used generic sound exposure thresholds to determine whether an activity produces underwater and in-air sounds that might result in impacts to marine mammals (70 FR 1871, 1872; January 11, 2005). NMFS has developed comprehensive guidance on sound levels likely to cause injury to marine mammals through onset of permanent and temporary thresholds shifts (PTS and TTS) (83 FR 28824; June 21, 2018; 81 FR 51693; August 4, 2016). NMFS is in the process of developing guidance for behavioral disruption (Level B harassment). However, until such guidance is available, NMFS uses the following conservative thresholds of underwater sound pressure levels,[35] expressed in root mean square (rms), [36] from broadband sounds that cause behavioral disturbance, and referred to as Level B harassment under section 3(18)(A)(ii) of the Marine Mammal Protection Act (MMPA) (16 U.S.C § 1362(18)(A)(ii)):

- impulsive sound: 160 dB_{rms} re 1 µPa
- non-impulsive sound: 120 dB_{rms} re 1µPa

---

[35] 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.

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

NMFS considers received levels above those of the measured ambient noise Level B harassment of marine mammals incidental to continuous noise, including vibratory pile driving (non-impulsive sound). NMFS draws a distinction between ambient sound levels (natural sound levels in the absence of all anthropogenic sound) and background sound (sound levels that include routine anthropogenic sound), and does not consider background sounds, including routine anthropogenic sounds, in the calculation of the area affected by project sound.

Ambient noise levels within Knik Arm are above the 120-dB threshold. The most recent acoustic monitoring in the absence of pile driving at the POA was conducted in May 2016 at two locations: "Ambient-Dock" and "Ambient-Offshore" (Austin et al. 2016, Denes and Austin 2016). The "Ambient-Offshore" measurements are the most applicable, as this location complies with a NMFS 2012 memo providing guidance on characterizing underwater background sound.[37] The median noise level collected at the "Ambient-Offshore" hydrophone was 122.2 dB, and we consider this value representative of the average ambient sound level (non-anthropogenic sound) at this location. The 122.2 dB isopleth will be used to define the threshold distance beyond which project-generated sound no longer causes Level B harassment of marine mammals. NMFS may adjust the 122.2 dB rms Level B harassment threshold for this location in the future, if warranted by additional data.

Under the PTS/TTS Technical Guidance, NMFS uses the following thresholds (Table 10) for underwater sounds that cause injury, referred to as Level A harassment under section 3(18)(A)(i) of the MMPA (16 U.S.C § 1362(18)(A)(i)) (NMFS 2018). Different thresholds and auditory weighting functions are provided for different marine mammal hearing groups, which are defined in the Technical Guidance (NMFS 2018). These acoustic thresholds are presented using dual metrics of cumulative sound exposure level (L_E) and peak sound level (PK) for impulsive sounds and L_E for non-impulsive sounds. The generalized hearing range for each hearing group is in Table 11. Level A harassment radii can be calculated using the optional user spreadsheet[38] associated with NMFS Acoustic Guidance, or through modeling.

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

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

[37] On January 31, 2012, NMFS Northwest Regional Office issued guidance to characterize underwater background sound (overall sound levels absent those from the proposed activity) in areas of proposed activities that have the potential to injure or disturb marine mammals. That guidance provides specific instructions for how to conduct the measurements. Included in this is spatial orientation of the hydrophones.

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

Exposure to sound capable of causing Level A or Level B harassment under the MMPA often, but not always, constitutes "take" under the ESA. For the purposes of this consultation, we have determined construction activities that produce non-impulsive (i.e., vibratory pile driving) and impulsive (i.e., impact pile driving) underwater sounds have sound source levels capable of causing take under the MMPA and ESA.

As described below, we anticipate that exposures to listed marine mammals from noise associated with the proposed action may result in disturbance and potential injury. However, no mortalities or permanent impairment to hearing are anticipated.

Table 10. PTS onset acoustic thresholds for Level A harassment (NMFS 2018).

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.

Table 11. Underwater marine mammal hearing groups (NMFS 2018).

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

6.2 Exposure Analysis

As discussed in the *Approach to the Assessment* section of this opinion, exposure analyses are designed to identify the listed species 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 sex of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. For critical habitat, exposure analyses identify any designated critical habitat likely to co-occur with effects and the nature of that co-occurrence. In this step of our analysis, we try to identify the physical and biological features likely to be exposed to an action's effects.

As discussed in Section 2.1.2 above, the POA proposed mitigation measures that should avoid or minimize exposure of Cook Inlet beluga whales, Mexico and WNP DPS humpback whales, and Western DPS Steller sea lions to one or more stressors from the proposed action.

NMFS expects that Cook Inlet beluga whales, humpback whales, and Steller sea lions will be exposed to underwater noise from pile driving activities (including vibratory pile driving and impact pile driving).

6.2.1 Ensonified Area

This section describes the operational and environmental parameters of each construction activity that allow NMFS to estimate the area ensonified above the acoustic behavioral thresholds, based on the construction activity occurring, as proposed by the POA.

The sound field in the action area is the existing background noise plus additional construction noise from the proposed project. Marine mammals may be affected via sound generated by the primary components of the project (i.e., vibratory pile driving and impact pile driving). NMFS used acoustic monitoring data from previous POA projects and other locations to develop the source levels used to calculate distances to the Level A and Level B thresholds for different sizes of piles and installation/removal methods. The values used and the source from which they were derived are summarized below and in Table 12.

While site-specific sound source verification studies have been conducted at the POA, the vast majority of the measurements recorded in those studies were made when bubble curtains were deployed around the sound source. Bubble curtains are not a feasible mitigation measure for the NES1 project due to the demolition and sequencing nature of the work. The majority of the proposed proxy values for this project, therefore, are based on measurements recorded from locations other than the POA.

Underwater sound was measured during installation of sheet piles at the POA in 2008 to assess potential impacts of sound on marine species. Sound levels, measured at 10 m, typically ranged from 147 to 161 dB rms, with a mean of approximately 155 dB rms (James Reyff, unpublished data). A sound source level of 162 dB rms for 24-inch steel sheet piles was reported in the California Department of Transportation (CalTrans) summary tables (CalTrans 2020). This sheet pile is more rigid than those that will be removed, and requires a large vibratory driver (James Reyff, personal communication, 26 August 2020). Based on the 2008 measurements at the POA and the CalTrans data, a value of 160 dB rms was assumed for vibratory removal of sheet piles.

For vibratory removal of the temporary stability template piles, NMFS considered and evaluated all source level data related to unattenuated vibratory removal of 24-inch and 36-inch steel pipe piles available. Ten measurements were available for unattenuated vibratory removal of 24-inch steel pipe piles, and the calculated average SPL from these studies was 169 dB rms (Table 12). Forty measurements were available for unattenuated vibratory removal of 36-inch piles, and the calculated average SPL from these studies was 159 dB rms.

The POA has indicated that the use of a pile splitter attachment during vibratory pile driving produces the same or similar sound levels as a vibratory hammer. The POA combined the use of a vibratory hammer and the splitter to remove sheet piles into a single category (i.e., vibratory removal). NMFS is currently unaware of any hydroacoustic measurements of pile splitting with a vibratory hammer.

NMFS developed a spreadsheet tool[39] to help implement the 2018 Technical Guidance (NMFS 2018f) that incorporates the duration of an activity into the estimation of a distance to the Level A isopleth. This estimation can then be used in conjunction with marine mammal density or occurrence to help predict exposures. NMFS notes that because of some of the assumptions included in the methods used for these tools, the isopleths estimated may be overestimates, and

[39] NMFS User Spreadsheet Tool, version 2.2 (updated December 2020), available at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance, accessed June 2023.

the resulting estimate of Level A harassment almost certainly overestimates the number of marine mammals that actually experience PTS if they should cross the Level A isopleth for fairly brief amounts of time. However, these tools offer the best available way to conservatively predict appropriate isopleths until more sophisticated modeling methods are widely available. NMFS continues to develop ways to quantitatively refine these tools, and will qualitatively address the output where appropriate. For stationary sources such as vibratory and impact pile driving, the NMFS User Spreadsheet predicts the distance at which a marine mammal would incur PTS if it remained at that distance for the duration of the activity.

Inputs used in the User Spreadsheet are shown in Table 12, and the resulting Level A isopleths are shown in Table 13. Level A harassment thresholds for impulsive sound sources are defined for both cumulative sound exposure levels (SELcum) and peak sound pressure level (SPLPK), with the threshold that results in the largest modeled isopleth for each marine mammal hearing group used to establish the Level A harassment isopleth.

Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (e.g., frequency, predictability, duty cycle), the environment (e.g., bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall et al. 2007, Ellison et al. 2012). Based on the available science and the practical need to use a threshold that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS predicts that marine mammals are likely to be behaviorally harassed when exposed to underwater anthropogenic noise above received levels of 120 dB re 1 μPa rms for non-impulsive sources (e.g., vibratory pile-driving) and above 160 dB re 1 μPa rms for non-explosive impulsive (e.g., impact pile-driving) or intermittent sources. The POA's proposed construction activity for the NES1 project includes the use of non-impulsive and impulsive sources, and therefore the 122.2 (average ambient sound level measured at the POA; see Section 6.1.2.1) and 160 dB re 1 μPa rms thresholds for behavioral harassment are applicable for this project.

Table 12. NMFS User Spreadsheet inputs for calculating Level A and Level B isopleths.

Activity	Pile Size/ Type	Transmission Loss Coefficient	Weighting Adjustment Factor (kHz)	Duration/Impacts per Pile	Piles per Day	Sound Source Level at 10 m	Reference
Vibratory Installation	24-inch* Steel Pipe	16.5	2.5	15 min/pile	12	161 dB rms	U.S. Navy (2015)
	36-inch* Steel Pipe			15 min/pile	12	166 dB rms	
Vibratory Removal	24-inch* Steel Pipe	16.5	2.5	15 min/pile	12	169 dB rms	Coleman (2011), I&R (2017, 2021, 2023)
	36-inch* Steel Pipe			15 min/pile	12	159 dB rms	U.S. Navy (2012), I&R (2021, 2023)
Vibratory or Splitter Removal	Sheet Pile	16.5	2.5	5 min/pile	24	160 dB rms	Caltrans (2015, 2020)
Impact Removal	Sheet Pile	15	2	50 strikes	3	179 dB SEL	Caltrans (2020)

* Temporary stability template piles will be either 24- or 36-inch steel pipe piles.

Table 13. Level A and Level B harassment isopleths for pile driving activities.

Activity	Pile Size/Type	Level A Harassment (m)			Level B Harassment (m)
		LF Cetacean	MF Cetaceans	Otariids	
Vibratory Installation	24-inch* Steel Pipe	14	2	1	2,247
	36-inch* Steel Pipe	28	4	2	4,514
Vibratory Removal	24-inch* Steel Pipe	42	4	3	6,861
	36-inch* Steel Pipe	11	2	1	1,700
Vibratory or Splitter Removal	Sheet Pile	10	1	1	1,954
Impact Removal	Sheet Pile	153	6	6	858

* Temporary stability template piles will be either 24- or 36-inch steel pipe piles.

Transmission loss (TL) is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. The general formula for underwater TL is:

$$TL = B * \mathrm{Log10}\,(R1/R2), \text{ where}$$

TL = transmission loss in dB
B = transmission loss coefficient
R1 = the distance of the modeled SPL from the driven pile
R2 = the distance from the driven pile of the initial measurement

Transmission loss coefficients were computed for various pile-driving activities during the POA Test Pile Program (TPP) and Petroleum Cement Terminal (PCT) construction. Sound level TL in Knik Arm was found to be complex and variable with direction. The TPP measured sounds mainly from 10 to about 1,000 meters, generally in direction to the southwest or northwest. TL coefficients were computed for unattenuated vibratory pile driving of 48-inch-diameter piles and summarized as 16.5 dB per each tenfold increase in distance. During PCT construction, measurements were conducted at fixed positions that ranged from 10 meters to about 2,800 meters in an east-to-west direction toward the deepest water in Knik Arm. Almost all measurements were made for attenuated conditions and the TL coefficients reported were highly variable and generally lower than values previously reported and used in the region.

Based on these data, NMFS used a transmission loss coefficient of 16.5 for unattenuated vibratory pile installation and removal during the NES1 project. This was the mean of the measurements collected during the TPP, and was composed of measurements from multiple directions (Austin et al. 2016). This transmission loss coefficient value is representative of all unattenuated vibratory measurements recorded in Knik Arm. The POA proposed the default practical spreading value of 15, recommended for most nearshore environments, for impact pile driving. This value results in an expected propagation environment that would lie between spherical and cylindrical spreading loss conditions. NMFS found these transmission loss rates acceptable and carried them forward in our analysis.

Using the practical spreading model, the underwater noise was determined to fall below the Level B threshold of 122.2 dB rms for marine mammals at a maximum radial distance of 6,861 m for vibratory removal of temporary 24-inch steel piles. Other pile driving activities have smaller Level B harassment zones. All Level B harassment isopleths are reported in Table 13.

6.2.2 Marine Mammal Occurrence and Exposure Estimates

For all ESA-listed species, NMFS relied on marine mammal monitoring data collected during past POA projects, as well as other monitoring data in the area to determine exposure estimates. These data cover the construction season (April through November) across multiple years.

Cook Inlet Beluga Whale

Beluga whales can be found in Knik Arm year-round, but are more frequently observed in the summer and fall. Large concentrations of belugas are present from August through October (61 North Environmental 2021, 2022a, Easley-Appleyard and Leonard 2022) and their movements in the area are typically characterized by traveling to upper Knik Arm with the high tide and following the low tide back down to Eagle Bay and the POA (McGuire and Stephens 2017).

The marine mammal monitoring programs for the PCT and SFD projects provided the most current and comprehensive dataset of Cook Inlet beluga whale locations and movements in Knik Arm (61 North Environmental 2021, 2022a, c). These monitoring programs included 11 PSOs observing from 4 elevated platforms positioned along a 9 km stretch of coastline surrounding the POA. PSOs used hand-held and 25-power Big Eye binoculars to detect and identify marine mammals, and theodolites to track beluga movements over time. Monitoring effort varied across projects, with data collected on 128 days during PCT Phase 1 in 2020, 74 days during PCT Phase 2 in 2021, and 13 days during the SFD project in 2022.

Additionally, NMFS AKR funded a marine mammal monitoring project that collected data during non-pile driving days during PCT Phase 2 in 2021 (Easley-Appleyard and Leonard 2022). NMFS replicated the POA monitoring efforts, as feasible, including use of two of the POA's monitoring platforms, deployment of four PSOs, equipment (handheld and Big Eye binoculars, theodolite), data collection software, and monitoring and data collection protocol. Observation periods were shorter (4 to 8 hrs), compared to PCT and SFD monitoring (~ 10 hrs). Despite the differences in effort, the NMFS dataset filled in gaps during the 2021 season when beluga presence in the area began to increase. Data were collected on 47 non-consecutive days from July through October.

The 2020-2022 monitoring programs detected, identified, located, and tracked belugas at greater distances from the proposed project site than previous monitoring programs (i.e., Kendall and Cornick 2015), and have contributed to a better understanding of beluga movements in upper Cook Inlet. Beluga sighting distances ranged from less than 10 m to up to nearly 15 km from the project site during these monitoring programs.

Given the recent evolution of the best available data of beluga presence in upper Cook Inlet, NMFS determined that changes to the sighting rate methodology used for calculating potential take of belugas for the PCT and SFD projects (85 FR 19294, April 6, 2020; 86 FR 50057, September 7, 2021, respectively) were appropriate. Additionally, the data used for the PCT and SFD sighting rate analyses (Kendall and Cornick 2015) were not included in the NES1 analysis due to changes in the monitoring programs and age of the data. Sighting data collected during the 2016 TPP (Cornick and Seagars 2016) were also not included because of the limited hours and seasonal coverage, as well as the differences in the monitoring programs. Monitoring data collected from 2020 to 2022 were selected for the NES1 project sighting rate analysis as they are the most current data available and are the most likely to accurately represent future beluga attendance at the project site (Table 14).

Table 14. Marine mammal monitoring data used for beluga sighting rate calculations.

Year	Monitoring Type and Data Source	# of Beluga Group Fixes	# of Beluga Groups	# of Belugas
2020	PCT: POA Construction Monitoring 61N Environmental 2021	2,653	245	987
2021	PCT: POA Construction Monitoring 61N Environmental 2022a	1,339	132	517
2021	PCT: NMFS Monitoring Easley-Appleyard and Leonard, 2022	694	109	575
2022	SFD: POA Construction Monitoring 61N Environmental 2022b	151	9	41

The sighting rate methodology used for the PCT and SFD projects included all beluga observations in Knik Arm, regardless of the sighting distance to the POA, to estimate a single monthly sighting rate. The monthly sighting rates were used to calculate beluga take for project activities, regardless of the size of the ensonified areas; take was calculated based on the monthly sighting rates and the estimated hours of activities. Additionally, exposure estimates for installation and removal of all pile sizes, regardless of pile driving method or implementation of attenuation systems, were identical.

The POA, in collaboration with NMFS, developed a new sighting rate methodology for the NES1 project. The new methodology incorporates a spatial component for beluga observations, which allows for a more accurate estimation of potential take of belugas. Beluga sightings in the 2020-2022 dataset include whales at distances far outside the estimated ensonified areas for the NES1 project. When determining appropriate sighting rates to use for take calculations, beluga sightings should be considered in relation to their distance to the NES1 project site. This will help ensure that the sighting rates used to estimate take are representative of beluga presence in the ensonified areas.

The POA calculated the closest point of approach (CPA) relative to the NES1 project site for each beluga group in the 2020-2022 dataset to incorporate a spatial component into the sighting rate methodology. The monitoring programs tracked belugas as they transited through Knik Arm, frequently collecting multiple locations for each group. The POA used the track lines, or single locations when only one sighting was available, to calculate the CPA for each group. The CPAs were calculated in ArcGIS software using the GPS coordinates recorded for sightings of each group and the NES1 location midpoint (centered on the project site). A group was defined as a sighting of one or more belugas as determined during data collection. The closest CPA to the NES1 project site was 15 m and the farthest was 11,057 m.

The cumulative density distribution of all CPA values was examined to determine appropriate distances for which to estimate spatially-derived beluga sighting rates (Figure 18). The POA used a piecewise regression model that detected breakpoints in the cumulative density distribution of the CPA locations. The breakpoints are points within the CPA data at which statistical properties of the sequence of sighting distances change, and represent spatially-based sighting rate bins for use in calculating beluga sighting rates. The POA used the "Segmented" package[40] in the R Statistical Software[41] to determine statistically significant breakpoints in the linear distances of the beluga data using this regression method. This analysis identified breakpoints in the CPA locations at 73.5 m, 1,650.9 m, 2,807.8 m, and 7,368.1 m (Figure 18).

Piecewise regression is a common tool for modeling ecological thresholds (Atwood et al. 2016, Whitehead 2016, Lopez et al. 2020). In a similar scenario, Mayette et al. (2022) used piecewise regression methods to model the distances between individuals in groups in nearshore and far shore environments. For the POA analysis, the breakpoints detect a change in the frequency of beluga groups sighted, and the slope of the line between two breakpoints indicates the magnitude of change. A greater positive slope indicates a greater accumulation of sightings over the linear distance (x-axis) between the defining breakpoints, and a more level slope (closer to zero) indicates a lower accumulation of sightings over that linear distance (Figure 18).

The breakpoints identified align with what is known about beluga behavior in Knik Arm based on recent monitoring efforts (61 North Environmental 2021, 2022a, c, Easley-Appleyard and Leonard 2022). Location data collected during POA monitoring programs indicate that belugas were consistently observed in higher numbers in the nearshore areas of both the east- and west-side shorelines, and were observed in lower numbers in the center of Knik Arm. Tracklines of beluga groups show a variety of movement patterns, including: swimming close to the eastern shore past the POA (captured by breakpoint 1 at 73.5 m); fewer belugas swimming in the center of Knik Arm (breakpoints 1 to 2, 73.5 to 1,650.9 m); and, swimming close to the western shore past the POA, with no whales able to swim farther from the POA in that area than the far shore (breakpoints 2 to 3, 1,650.9 to 2,807.8 m). Behaviors and locations beyond breakpoint 4 (7,368.1 m) include swimming past the mouth of Knik Arm between the Susitna River area and Turnagain Arm, milling at the mouth of Knik Arm but not entering the Arm, and milling to the northwest of the POA without exiting Knik Arm. The shallowness of slope 5 (distances greater than 7,368.1 m), could be due to detection falloff from distance bias, as PSOs are less likely to detect groups farther away.

[40] https://cran.r-project.org/web/packages/segmented/index.html Accessed September 2023.
[41] https://www.r-project.org/ Accessed September 2023.

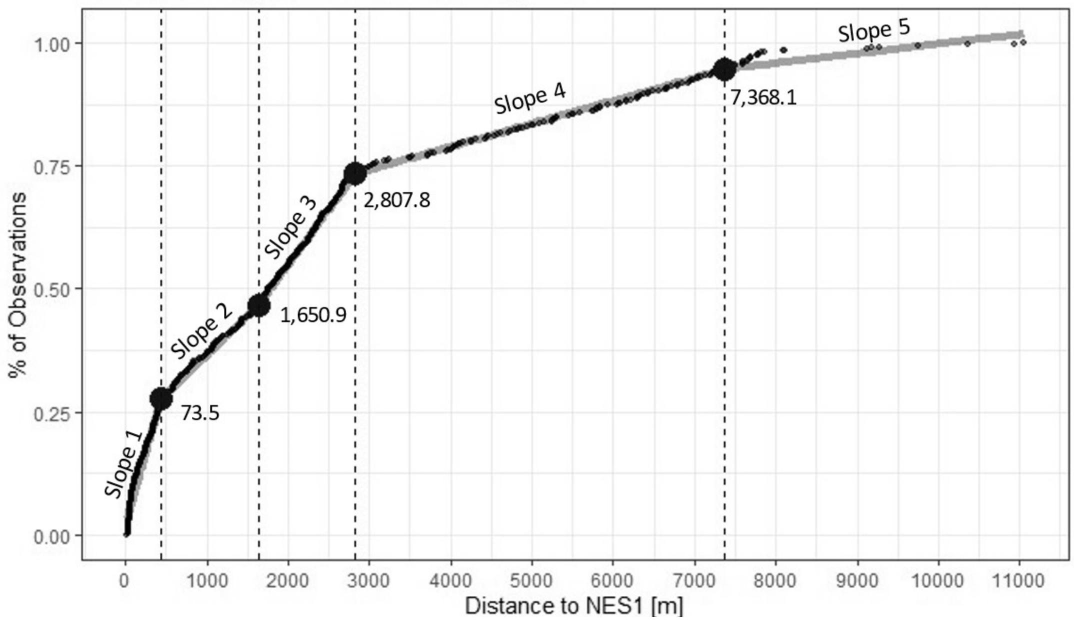

Figure 18. Percent of beluga CPAs in relation to distance from the NES1 project site and associated breakpoints determined by piecewise linear regression.

The distances detected by the breakpoint analysis were used to define five sighting rate distance bins for belugas in the NES1 project area. Each breakpoint was rounded up to the nearest meter and considered the outermost limit of each sighting rate bin (Table 15). All observations less than the breakpoint distance for each bin were used to calculated the respective monthly sighting rates (e.g., all sightings from 0 to 74 m are included in the sighting rates calculated for bin 1, all sightings from 0 to 1,651 m are included in the sighting rates calculated for bin 2, and so on). The NES1 project is expected to occur from April through November, and monthly sighting rates were derived for these months (Table 15).

Table 15. Beluga monthly sighting rates for different spatially-based bins.

		Belugas per Hour[1]							
Bin	**Distance (m)**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
1	≤ 74	0.09	0.06	0.10	0.04	0.83	0.62	0.51	0.11
2	≤ 1,651	0.25	0.14	0.13	0.06	1.43	1.30	1.15	0.70
3	≤ 2,808	0.36	0.22	0.21	0.07	2.08	1.90	2.04	0.73
4	≤ 7,369	0.67	0.33	0.29	0.13	2.25	2.19	2.42	0.73
5	> 7,369	0.71	0.39	0.30	0.13	2.29	2.23	2.56	0.73

[1] Observation hours from the PCT 2020 and 2021, NMFS 2021, and SFD 2022 monitoring programs were totaled (61 North Environmental 2021, 2022a, c, Easley-Appleyard and Leonard 2022).

Potential exposures (takes) were calculated by multiplying the total number of vibratory installation or removal hours per month for each size/type pile (based on the estimated construction schedule; Table 4) by the corresponding sighting rate and sighting rate distance bin (Table 16). For example, the Level B harassment isopleth for vibratory installation of 24-inch piles is 2,247 m, which falls into bin 3. Take for this activity is calculated by multiplying the total number of hours estimated each month to install 24-inch piles via a vibratory hammer by the monthly sighting rates calculated for bin 3. The resulting estimated beluga whale exposures were totaled for all activities in each month (Table 17).

Removal of the 24-inch template piles will result in louder SPLs and larger Level B harassment isopleths compared to the 36-inch piles. However, the opposite is true for installation of the template piles; the 36-inch piles will result in louder SPLs and larger Level B harassment isopleths compared to the 24-inch piles. Regardless of the template pile size selected (24- or 36-inch) for the NES1 project, the potential impacts on marine mammals are expected to be fungible; the potential impacts of installation and removal of 24-inch steel pipe piles are expected to be comparable to the potential impacts of installation and removal of 36-inch steel pipe piles. Using the monthly activity estimates in hours and monthly calculated sighting rates (belugas/hour) for the spatially derived distance bins, the POA estimates that up to 122 Cook Inlet beluga whales could be exposed to Level B harassment during the NES1 project (Table 17).

NMFS accounted for the implementation of mitigation measures (e.g., shutdown procedures when belugas approached and/or entered the Level B harassment zone) for the PCT and SFD projects by applying an adjustment factor to the beluga take estimates; some Level B harassment takes would likely be avoided based on required shutdowns. For the PCT project, NMFS compared the number of realized takes to the number of authorized takes for POA projects from 2008 to 2017. The percentage of realized takes ranged from 12 to 59 percent with an average of 36 percent. NMFS applied the highest percentage of realized takes (59 percent during the 2009-2010 season) to ensure the POA had authorization for an amount of take that is reasonably certain to occur. This reasoning inferred that approximately 59 percent of the beluga Level B harassment takes calculated would be realized during PCT and SFD construction, and 41 percent would be avoided by successful implementation of the required mitigation measures.

Data from the PCT Phase 1 and Phase 2 project most accurately reflect the proposed marine mammal monitoring program and its effectiveness, as well as beluga attendance in the NES1 project area. In total, 90 Level B harassment takes were authorized and 53 were potentially realized, resulting in a 59 percent realized take for the PCT project. During the SFD project, 7 percent of authorized take occurred; however, only 12 piles were installed during a brief period of time. This is not representative of the much higher number of piles and longer construction season expected for the NES1 project. For these reasons, the adjustment for successful implementation of mitigation measures for the NES1 project was calculated using the percentage of realized takes from the PCT project (59 percent).

The 59 percent adjustment accurately accounts for the efficacy of the POA’s marine mammal monitoring program and required shutdown protocols. This robust monitoring program will be implemented for the NES1 project in order to maintain consistency in both data collection and analysis, including estimation of potential exposure to elevated sound levels. By applying the 59 percent adjustment factor, we are authorizing the POA for the amount of take that is reasonably certain to occur. The calculated potential takes by Level B harassment of belugas is adjusted from 122 to 72 takes by Level B harassment (Table 17). Take by Level A harassment is not expected or authorized; the POA will be required to shut down activities when Cook Inlet belugas approach and/or enter the Level B harassment zone.

Table 16. Allocation of Level B harassment isopleths to sighting rate distance bins and associated beluga monthly sighting rates.

Activity	Pile Size/Type	Level B Harassment (m)	Sighting Rate Bin and (Distance)	Belugas/Hour							
				Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Vibratory Installation	24-inch* Steel Pipe	2,247	3 (2,808 m)	0.36	0.22	0.21	0.07	2.08	1.90	2.04	0.73
	36-inch* Steel Pipe	4,514	4 (7,369 m)	0.67	0.33	0.29	0.13	2.25	2.19	2.42	0.73
Vibratory Removal	24-inch* Steel Pipe	6,861	4 (7,369 m)	0.67	0.33	0.29	0.13	2.25	2.19	2.42	0.73
	36-inch* Steel Pipe	1,700	3 (2,808 m)	0.36	0.22	0.21	0.07	2.08	1.90	2.04	0.73
Vibratory or Splitter Removal	Sheet Pile	1,954	3 (2,808 m)	0.36	0.22	0.21	0.07	2.08	1.90	2.04	0.73
Observation Hours/Month[1]				87.9	615.1	571.6	246.9	224.5	326.2	109.5	132.0

* Temporary stability template piles will be either 24- or 36-inch steel pipe piles.
[1] Observation hours from the PCT 2020 and 2021, NMFS 2021, and SFD 2022 monitoring programs were totaled (61 North Environmental 2021, 2022a, c, Easley-Appleyard and Leonard 2022).

Table 17. Monthly pile driving hours, beluga sighting rates, and potential beluga Level B harassment exposures.

Pile Size/ Type	Activity	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
24-inch* Steel Pipe	Install (hrs)	6.75	3.50	3.50	2.50	2.50	0.75	0.75	0.00	20.25
	Belugas/Hour	0.36	0.22	0.21	0.07	2.08	1.90	2.04	0.73	-
	Exposures	2.4	0.8	0.7	0.2	5.2	1.4	1.5	0	12.3
	Remove (hrs)	0.00	6.75	3.25	3.25	3.25	2.50	1.00	0.25	20.25
	Belugas/Hour	0.67	0.33	0.29	0.13	2.25	2.19	2.42	0.73	-
	Exposures	0	2.2	0.9	0.4	7.3	5.5	2.4	0.2	19.0
	Total Installation and Removal Hours				40.5				Total Exposures	31.3
36-inch* Steel Pipe	Install (hrs)	6.75	3.5	3.5	2.5	2.5	0.75	0.75	0	20.25
	Belugas/Hour	0.67	0.33	0.29	0.13	2.25	2.19	2.42	0.73	-
	Exposures	4.5	1.2	1.0	0.3	5.6	1.6	1.8	0	16.10
	Remove (hrs)	0	6.75	3.25	3.25	3.25	2.5	1	0.25	20.25
	Belugas/Hour	0.36	0.22	0.21	0.07	2.08	1.90	2.04	0.73	-
	Exposures	0.00	1.5	0.7	0.2	6.8	4.8	2.0	0.2	16.1
	Total Installation and Removal Hours				40.5				Total Exposures	32.2
Sheet Pile	Remove (hrs)	10	45	60	60	13	12	4	2	206
	Belugas/Hour	0.36	0.22	0.21	0.07	2.08	1.90	2.04	0.73	-
	Exposures	3.6	9.9	12.6	4.2	27.0	22.8	8.2	1.5	89.8
	Total Installation and Removal Hours				206				Total Exposures	89.8
Total Estimated Level B Harassment Exposures for All Activities:										122
Total Estimated Level B Harassment Exposures with 59 Percent Correction Factor:										72

* Temporary stability template piles will be either 24- or 36-inch steel pipe piles.

Mexico and WNP DPS Humpback Whale

Sightings of humpback whales in the action area are rare, and few, if any, humpbacks are expected to approach the project area. While most humpback whales have been observed in lower Cook Inlet, there have been several sightings in the upper inlet in recent years.

Two humpbacks were observed north of the Forelands during marine mammal monitoring in May and June of 2015 (Jacobs Engineering Group 2017). Marine mammal monitoring near the mouth of Ship Creek also recorded two humpback whale sightings, likely of the same individual, in September 2017 (ABR 2017). Two sightings of three humpback whales were recorded near Ladd Landing, north of the Forelands, in 2018 during marine mammal monitoring (Sitkiewicz et al. 2018).

The maximum number of humpback whale sightings observed in upper Cook Inlet within a single monitoring season was two and the maximum number of humpbacks observed in a sighting was two. Therefore, NMFS AKR expects that four humpback whales could be exposed to Level B harassment from pile driving noise. This could include cow-calf pairs or four sightings of single humpback whales. Here we assume that if an animal is present in the ensonified area, it will be exposed to acoustic harassment, acknowledging that not all animals within the action area will be so exposed. In Cook Inlet, 11 percent of humpback whales are expected to be from the ESA-listed Mexico DPS and <1 percent are expected to be from the ESA-listed WNP DPS (Wade 2021). Therefore, NMFS expects that a fraction of one individual, rounded up to one individual, from the Mexico or WNP DPS may be exposed to Level B harassment from pile driving noise.

The maximum distance at which a humpback whale may be exposed to noise levels that exceed Level A thresholds is ~153 m during impact hammering. PSOs will be on-watch during impact pile driving, and the shutdown zones can be effectively monitored and mitigation implemented. The large size of humpback whales increases the likelihood of detection; however, should a humpback be observed within the Level A harassment zone, the mitigation measures make it unlikely that an animal would accumulate enough exposure to sound for PTS to occur. For these reasons, and due to the small percentage of Mexico and WNP DPS humpback whales occurring in the action area, take by Level A harassment is not expected or authorized.

Western DPS Steller Sea Lion

Sightings of Steller sea lions in middle and upper Cook Inlet are uncommon; however, several Steller sea lion sightings have been recorded during monitoring efforts for POA projects in recent years. Up to six Steller sea lions were observed during Phase 1 PCT construction monitoring in 2020 (61 North Environmental 2021), nine Steller sea lions were observed during monitoring associated with Phase 2 PCT construction in 2021 (61 North Environmental 2022a, Easley-Appleyard and Leonard 2022), and three Steller sea lions were observed during the SFD construction monitoring in 2022 (61 North Environmental 2022c).

The hourly sighting rate for Steller sea lions in 2021, the most recent year with observations across most months, was approximately 0.01. The hourly sighting rate for Steller sea lions during

SFD construction (May and June of 2022) was 0.028. Based on the higher sighting rate of 0.028 and the planned 246.5 hours of in-water pile installation and removal for the NES1 project, an exposure estimate of 6.9 individuals, rounded up to 7 individuals, was calculated (0.028 sea lions per hour * 246.5 hours). However, the maximum number of Steller sea lions observed at the POA during the 2020-2022 monitoring efforts was nine individuals in 2021, eight during PCT Phase 1 monitoring and one during NMFS monitoring. Given the uncertainty around Steller sea lion attendance at the POA, NMFS AKR expects that nine Western DPS Steller sea lions could be exposed to Level B harassment from pile driving noise. Here we assume that if an animal is present in the ensonified area, it will be exposed to acoustic harassment, acknowledging that not all animals within the action area will be exposed.

The maximum distance at which a Steller sea lion may be exposed to noise levels that exceed Level A thresholds is 6 m during impact hammering. PSOs will be on-watch during impact pile driving, and the shutdown zones can be effectively monitored and mitigation implemented. Should a Steller sea lion be observed within the Level A harassment zone, the mitigation measures make it unlikely that an animal would accumulate enough exposure for PTS to occur. For these reasons, take by Level A harassment is not expected or authorized.

Table 18 summarizes the estimated exposures of Cook Inlet beluga whales, Mexico and WNP DPS humpback whales, and Western DPS Steller sea lions to pile driving sound.

Table 18. Expected exposures of ESA-listed species.

Species	Level A	Level B[1]
Cook Inlet beluga whale	0	72
Mexico and WNP DPS humpback whale	0	1
Western DPS Steller sea lion	0	9

[1] Exposure estimates are rounded up to the nearest whole number.

6.3 Response Analysis

As discussed in the *Approach to the Assessment* section of this opinion, response analyses determine how listed species/critical habitats 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. For critical habitat, our assessments try to identify which of the action's effects will impact or alter the physical and biological features of critical habitat and the magnitude of the impacts or alterations relative to the value of critical habitat as a whole for the conservation of a listed species. Ideally, our response analyses consider and weigh evidence of adverse consequences, beneficial consequences, or the absence of such consequences.

Loud underwater noise can result in physical effects on the marine environment that can affect marine organisms. Possible responses by Cook Inlet beluga whales, Mexico and WNP DPS humpback whales, and Western DPS Steller sea lions to the impulsive and non-impulsive sound produced by pile driving activities include:

- Physical Response
  - Temporary or permanent hearing impairment (threshold shifts)
  - Non-auditory physiological effects
- Behavioral responses
  - Auditory interference (masking)
  - Tolerance or habituation
  - Change in dive, respiration, or feeding behavior
  - Change in vocalizations
  - Avoidance or displacement
  - Vigilance
  - Startle or fleeing/flight

6.3.1 Responses to Major Noise Sources (Pile Driving Activities)

As described in the Exposure Analysis, Cook Inlet beluga whales, Mexico and WNP DPS humpback whales, and Western DPS Steller sea lions are expected to occur in the action area and to overlap with noise associated with pile installation and removal activities. We assume that some individuals are likely to be exposed and respond to these impulsive and non-impulsive noise sources.

With proper implementation of the mitigation measures and shutdown procedures described in Section 2.1.2, we do not expect that any listed marine mammals will be exposed to noise levels loud enough, long enough, or at distances close enough for the proposed action to result in harm to the animal. In other words, we expect no permanent hearing impairment or other injury. We expect no more than 72 exposures of Cook Inlet beluga whales, 1 exposure of Mexico or WNP DPS humpback whales, and 9 exposures of Western DPS Steller sea lions to noise levels sufficient to cause harassment, as described in Section 6.2.2. All instances of harassment are expected to occur at received levels greater than 122.2 dB and 160 dB for non-impulsive and impulsive noise sources, respectively, meaning some physical and behavioral responses could occur.

The introduction of anthropogenic noise into the aquatic environment from pile driving activities is the primary means by which marine mammals may be harassed from project activities covered in this opinion. In general, animals exposed to natural or anthropogenic sound may experience physical and physiological effects, ranging in magnitude from none to severe (Southall et al. 2007). Exposure to anthropogenic noise can also lead to non-observable physiological responses such an increase in stress hormones. Additional noise in marine mammal habitat can mask acoustic cues used by marine mammals to carry out daily functions such as communication and predator and prey detection.

Exposure to pile driving and removal noise has the potential to result in auditory threshold shifts and behavioral reactions (e.g., avoidance, temporary cessation of foraging and vocalizing, changes in dive behavior). The effects of pile driving and removal noise on marine mammals are dependent on several factors, including, but not limited to, sound type (e.g., impulsive vs. non-impulsive), the species, age and sex class (e.g., adult male vs. cow with calf), duration of exposure, the distance between the pile and the animal, received levels, behavior at time of exposure, and previous history with exposure (Wartzok et al. 2003, Southall et al. 2007). Here we discuss physical auditory effects (threshold shifts) followed by behavioral effects.

6.3.1.1 Threshold Shifts

NMFS defines a noise-induced threshold shift (TS) as a change, usually an increase, in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level (NMFS 2018f). In other words, a threshold shift is a hearing impairment, and may be temporary (such as ringing in your ears after a loud rock concert) or permanent (such as the loss of the ability to hear certain frequencies or partial or complete deafness). There are numerous factors to consider when examining the consequence of TS, including: the signal's temporal pattern (e.g., impulsive or non-impulsive); likelihood an individual would be exposed for a long enough duration or to a high enough level to induce a TS; the magnitude of the TS; time to recovery; the frequency range of the exposure (i.e., spectral content); the hearing and vocalization frequency range of the exposed species relative to the signal's frequency spectrum (i.e., how an animal uses sound within the frequency band of the signal; Kastelein et al. 2014); and the overlap between the animal and the sound (e.g., spatial, temporal, and spectral; NMFS 2018f). The amount of threshold shift is customarily expressed in dB.

Temporary Threshold Shift

Temporary threshold shift (TTS) is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1970). While experiencing TTS, the hearing threshold rises, and a sound must be stronger in order to be heard. In terrestrial mammals, TTS can last from minutes to days (in cases of strong TTS). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the sound ends. Few data exist on the sound levels and durations necessary to elicit mild TTS in marine mammals, and none of the published data describe TTS elicited by exposure to multiple pulses of sound. Available data on TTS in marine mammals are summarized in (Southall et al. 2007).

Although some exposures to sound capable of causing harassment may occur during the course of the proposed action, not all instances will result in TTS because the estimated noise thresholds for the onset of TTS are conservative. If TTS does occur, it is expected to be mild and temporary and not likely to affect the long term fitness of the affected individuals.

Permanent Threshold Shift

When permanent threshold shift (PTS) occurs, there is physical damage to the sound receptors in the ear. The animal will have an impaired ability to hear sounds in specific frequency ranges, and there can be total or partial deafness in severe cases (Kryter 1985). There is no specific evidence that exposure to pulses of sound can cause PTS in any marine mammal. However, given the possibility that mammals close to a sound source can incur TTS, it is possible that some individuals will incur PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing the onset of TTS might elicit PTS.

Relationships between TTS and PTS thresholds have not been studied in marine mammals but are assumed to be similar to those in humans and other terrestrial mammals, based on anatomical similarities. PTS might occur at a received sound level at least several decibels above that which induces mild TTS, if the animal were exposed to strong sound pulses with rapid rise time. For non-impulsive exposures (i.e., vibratory pile driving), a variety of terrestrial and marine mammal data sources indicate that threshold shift up to 40 to 50 dB may be induced without PTS, and that 40 dB is a conservative upper limit for threshold shift to prevent PTS. An exposure causing 40 dB of TTS is, therefore, considered equivalent to PTS onset (NMFS 2018f).

The shutdown zones to be implemented are larger than the calculated isopleths to reduce the likelihood that listed marine mammals are exposed to noise levels that could cause PTS or other harmful disturbance. No exposures are expected at levels resulting in PTS due to conservative estimates of MMPA Level A acoustic isopleths and mitigation measures to shut down pile driving activities if a beluga whale, humpback whale, or Steller sea lion approaches a Level A zone.

6.3.1.2 Non-auditory Physiological Effects

Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, internal bubble formation, resonance effects, and other types of organ or tissue damage (Cox et al. 2006, Southall et al. 2007). Studies examining such effects are limited. In general, little is known about the potential for pile driving activities to cause auditory impairment or other physical effects in marine mammals. Available data suggest that such effects, if they occur at all, would presumably be limited to short distances from the sound source and to activities that extend over a prolonged period of time. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall et al. 2007) or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. Marine mammals that show behavioral avoidance of pile driving are especially unlikely to incur auditory impairment or non-auditory physical effects.

An animal’s perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (Moberg 2000). In many cases, an animal’s first, and sometimes most economical (in terms of energetic costs), response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal’s fitness.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and “distress” is the cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose serious fitness consequences.

However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other functions. This state of distress will last until the animal replenishes its energetic reserves sufficient to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well-studied through controlled experiments and for both laboratory and free-ranging animals (Jessop et al. 2003, Lankford et al. 2005, Crespi et al. 2013). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker 2000, Romano et al. 2002) and, more rarely, studied in wild populations (Romano et al. 2002). For example, noise reduction from reduced ship traffic in the Bay of Fundy following September 11, 2001 was linked to 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 stress hormones returned to their previous level within 24 hours 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).

These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as “distress”. In addition, any animal experiencing TTS would likely also experience stress responses (NRC 2003).

The estimated 246.5 hours of pile driving activities will be staggered over 110 days during a 12 month period and occur for a limited amount of time on each day of in-water work, thus limiting the potential for chronic stress. Marine mammals that show behavioral avoidance of pile driving are especially unlikely to incur auditory impairment or non-auditory physical effects, like stress and distress, because they will be limiting the duration of their exposure.

6.3.1.3 Behavioral Disturbance Reactions

Behavioral responses are influenced by an animal’s assessment of whether a potential stressor poses a threat or risk. Behavioral responses may include: changing durations of surfacing and dives, number of blows per surfacing, or changing direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where sound sources are located; and/or, flight responses.

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. Behavioral responses to sound are highly variable and context-specific, and reactions, if any, depend on species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day, and many other factors (Southall et al. 2007).

Tolerance can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok et al. 2003). Animals are most likely to tolerate, and possibly habituate to, sounds that are predictable and unvarying. The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. Behavioral state may affect the type of response as well. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson et al. 1995, NRC 2003, Wartzok et al. 2003).

Controlled experiments with captive marine mammals showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway et al. 1997, Finneran et al. 2003). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic guns or acoustic harassment devices, but also pile driving) have been varied, but often consist of avoidance behavior or other behavioral changes, suggesting discomfort (Morton and Symonds 2002, Wartzok et al. 2003, Thorson and Reyff 2006, Nowacek et al. 2007). Responses to non-impulsive sound, such as vibratory pile installation, have not been documented as well as responses to pulsed sounds.

Beluga whales and other odontocetes have been shown to exhibit behavioral changes when exposed to very loud impulsive sound (Finneran et al. 2000, Finneran et al. 2002b). Some whales may change their behavioral state – reduce the amount of time they spend at the ocean’s surface, increase their swimming speed, change their swimming direction, change their respiration rates, increase dive times, reduce feeding behavior, and/or alter vocalizations and social interactions (Frid and Dill. 2002, Koski et al. 2009, Funk et al. 2010, Melcon et al. 2012, Kendall, Sirovic and Roth 2014, Kendall and Cornick 2015). Beluga whales were observed before and during pile driving activity at the POA; a decrease in sighting duration, an increase in traveling relative to other observed behaviors, and a change in group composition were documented during pile driving activity (Kendall and Cornick 2015). Baleen whales have shown strong overt reactions to impulsive noises at received levels between 160 and 173 dB_{rms} re 1 µPa (Richardson, Wursig and Greene 1986, Ljungblad et al. 1988, McCauley et al. 2000, Miller et al. 2005, Gailey, Würsig and McDonald 2007). Humpbacks exposed to pile driving noise are most likely to respond by avoiding the area (Richardson et al. 1995); changes in vocal behavior could also occur. Steller sea lions exposed to pile driving noise may change their behavioral state by avoiding these sound fields or exhibiting vigilance by raising their heads above the water. In general, pinnipeds seem more tolerant of low frequency noise and less responsive to exposure to industrial sound than most cetaceans (Costa et al. (2003).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be biologically significant if the change affects growth, survival, or fitness. Significant behavioral modifications that could potentially lead to effects on growth, survival, or fitness include drastic changes in diving/surfacing patterns, longer-term habitat abandonment due to loss of desirable acoustic environment, longer-term cessation of feeding or social interaction, and cow/calf separation.

The onset of behavioral disturbance from anthropogenic sound depends on both external factors (characteristics of sound sources and their paths) and the specific characteristics of the receiving animals (hearing, motivation, experience, demography), and is difficult to predict (Southall et al. 2007).

6.3.1.4 Auditory Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with, a marine mammal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher levels. Chronic exposure to excessive, though not high-intensity, sound could cause masking at particular frequencies for marine mammals that utilize sound for vital biological functions. Masking can interfere with detection of acoustic signals such as communication calls, echolocation sounds, and environmental sounds important to marine mammals. Therefore, under certain circumstances, marine mammals whose acoustical sensors or environment are being severely masked could also be impaired from maximizing their performance or fitness in survival and reproduction. If the coincident (masking) sound were anthropogenic, it could be potentially harassing if it disrupted hearing-related behavior. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs only during the sound exposure. Because masking (without resulting in threshold shift) is not associated with abnormal physiological function, it is not considered a physiological effect, but may result in a behavioral effect.

Masking occurs at the frequency band the animals utilize, so the frequency range of the potentially masking sound is important in determining any potential behavioral impacts. Lower frequency man-made sounds are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey sound. Anthropogenic sounds may also affect communication signals when both occur in the same sound band and thus reduce the communication space of animals (Clark et al. 2009, Eickmeier and Vallarta 2022), and cause increased stress levels (Foote, Osborne and Hoelzel 2004, Holt et al. 2009).

Masking has the potential to affect species at the population or community levels as well as at individual levels. Masking affects both senders and receivers of the signals and can potentially have long-term chronic effects on marine mammal species and populations. Research suggests that low frequency ambient sound levels have increased by as much as 20 dB (more than a three-fold increase in terms of SPL) in the world's ocean from pre-industrial periods, and that most of these increases are from distant shipping (Hildebrand 2009). All anthropogenic sound sources, such as those from vessel traffic, pile driving, and dredging activities, contribute to the elevated ambient sound levels, thus intensifying masking.

Noise from pile driving activities may mask acoustic signals important to beluga whales, humpback whales, and Steller sea lions. However, pile driving activities will be intermittent, occur during daylight hours, and affect a limited area. Masking only exists for the duration of time that the masking sound is emitted (and interfering with biologically important sounds); extended periods of time where masking could occur are not expected.

Masking is likely less of a concern for Steller sea lions, which vocalize both in air and water and do not echolocate or communicate with complex underwater "songs". Any masking event that could harass sea lions would occur concurrently within the zones of behavioral harassment already estimated for pile driving activities, which have already been taken into account in the Exposure Analysis.

6.3.2 Response Analysis Summary

Possible responses of listed species to pile driving activities include:

- Physical Response
  - Temporary hearing impairment (threshold shift)
  - Non-auditory physiological effects
- Behavioral responses
  - Auditory interference (masking)
  - Tolerance or habituation
  - Change in dive, respiration, or feeding behavior
  - Change in vocalizations
  - Avoidance or displacement
  - Vigilance
  - Startle or fleeing/flight

These reactions and behavioral changes are expected to be temporary and subside quickly when the exposure ceases. The primary mechanism by which these behavioral changes may affect the fitness of individual animals is through the animals' energy budget, time budget, or both (the two are related because foraging requires time). Some animals may leave the area during pile driving activities if they were disturbed, and high-quality habitat is located throughout Cook Inlet. The individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of beluga whales, humpback whales, or Steller sea lions, and their probable exposure to noise sources are not likely to reduce their fitness.

7. CUMULATIVE EFFECTS

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area (50 CFR § 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate change within the action area. However, it is difficult 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 Status of the Species and the Environmental Baseline sections.

We searched for information on non-Federal actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than what has already been described in the Environmental Baseline section and those summarized below. Reasonably foreseeable future state, local, or private actions include vessel traffic and shipping, state fisheries, pollution, and tourism, and are discussed in the following sections.

7.1 Vessel Traffic and Shipping

Vessel traffic, including shipping, is expected to continue in Cook Inlet. It is unknown whether overall vessel traffic or shipping will increase in the future, as this depends largely on population growth, economics, tourism, and other factors, but it is unlikely to decrease significantly. As a result, there will be continued risk to marine mammals of ship strikes, exposure to vessel noise and presence, and small spills.

7.2 Fisheries (State of Alaska managed)

ADFG manages fish stocks and monitors and regulates fishing under the state jurisdiction in Cook Inlet to maintain sustainable stocks. Fishing, a major industry in Alaska, is expected to continue in the area. As a result, there will be continued risk to marine mammals of prey competition, ship strikes, harassment, and entanglement in fishing gear. For Cook Inlet beluga whales, there is also a risk of continued displacement from former summer foraging habitat due to human activity associated with salmon harvest (Ovitz 2019). It remains unknown whether and to what extent marine mammal prey may become less available due to commercial, subsistence, personal use, and sport fishing, especially near the mouths of streams up which salmon and eulachon migrate to spawning areas. In addition, we do not know the full extent of the effects of fishing vessel traffic on availability of prey to belugas. The Cook Inlet Beluga Whale Recovery Plan considers reduction in availability of prey due to activities such as fishing to be a moderate threat to the population (NMFS 2016b).

7.3 Pollution

As the population in urban areas around Cook Inlet continues to grow, an increase in pollutants entering Cook Inlet is likely to occur. Hazardous materials are released into Cook Inlet from vessels, aircraft, and municipal runoff. Oil spills could occur from vessels traveling within the action area. In addition, oil spilled from outside the action area could migrate into the action area. There are many nonpoint sources of pollution within the action area. Pollutants can pass from streets, construction and industrial areas, and airports into Cook Inlet. The EPA and the ADEC will continue to regulate the amount of pollutants that enter Cook Inlet from point and nonpoint sources through NPDES/APDES permits. As a result, permittees will be required to renew their permits, verify they meet permit standards, and potentially upgrade facilities.

7.4 Tourism

Currently there are no commercial whale-watching companies in upper Cook Inlet. The extremely hazardous environmental and boating conditions, lack of harbors, and single boat launching facility in the Anchorage area (that cannot be used at low tides) make it unlikely that commercial whale-watching will occur in the area. However, some aircraft have circled groups of Cook Inlet beluga whales, disrupting their breathing patterns and possibly their feeding activities. In response, NMFS has undertaken outreach efforts to educate local pilots of the potential consequences of such actions, providing guidelines and encouraging pilots to “stay high and fly by”.

Watercraft (primarily sport fishing watercraft) have been observed to harass belugas in the Twentymile River. NMFS is cooperating with partners to assess the degree to which such boating activities may be a cause for concern due to the associated reduced access to concentrations of prey.

8. INTEGRATION AND SYNTHESIS

The Integration and Synthesis section is the final step of NMFS’s assessment of the risk posed to listed 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 direct or indirect alterations that appreciably diminish the value of designated critical habitat as a whole for the conservation of the species. These assessments are made in full consideration of the status of the species (Section 4).

As we discussed in the *Approach to the Assessment* section of this opinion, we begin our risk analyses by asking whether the probable physical, physiological, behavioral, or social responses of endangered or threatened species are likely to reduce the fitness of endangered or threatened individuals or the growth, annual survival or reproductive success, or lifetime reproductive success of those individuals.

As part of our risk analyses, we identified and addressed all potential stressors and considered all consequences of exposing listed species to all 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.

8.1 Cook Inlet Beluga Whale Risk Analysis

Based on the results of the exposure analysis, we expect 72 Cook Inlet beluga whales may be exposed to noise from pile driving. Beluga whales can be found in Knik Arm year-round, but are more frequently observed in the area during the summer and fall. The most recent population estimate as of 2023 is 331 animals (Goetz et al. 2023). The trend in the updated time-series, including the 2021 and 2022 survey data, suggests the population is stable and may be slightly increasing (Goetz et al. 2023). From 2008 to 2018 the population showed a declining trend of 2.3 percent per year (Shelden and Wade 2019).

Exposure to project-related vessel noise and risk of vessel strike may occur, but adverse effects from vessel disturbance and noise are likely to be insignificant due to the small marginal increase in such activities relative to the environmental baseline, the transitory nature of project-related vessel traffic, and the likely habituation of whales that frequent this heavily trafficked area. Adverse effects from vessel strikes are considered extremely unlikely because of the few additional vessels introduced by the action, slow speeds at which these vessels will operate, and the 100 m shutdown zone that will be implemented by transiting project vessels.

Disturbance to seafloor, habitat, and prey resources are not expected to adversely affect belugas because these disturbances are temporary. Based on the localized nature of small unauthorized spills, the relatively rapid weathering expected, and the safeguards in place to avoid and minimize spills, we conclude that the probability of the proposed action causing a small spill and exposing beluga whales is extremely small, and thus the effects are considered highly unlikely to occur. Exposure to pollutants and marine debris is extremely unlikely to occur.

Pile driving noise at the POA could restrict beluga access to important foraging areas north of the project site, or inhibit whales from swimming south past the project site and leaving Knik Arm. Changes in behavior, such as increased traveling and swimming speed, as well as changes in group composition have been recorded during previous POA pile driving activities (Kendall and Cornick 2015). Belugas continued to travel past the POA into upper Knik Arm and to leave Knik Arm despite pile driving. During yearly dredging operations, belugas have also been observed traveling past the POA. With the proposed mitigation measures, we expect that belugas will continue to travel past the POA to and from feeding areas during the NES1 project.

The implementation of mitigation measures (including shutdown zones) to reduce exposure to high levels of sound decrease the likelihood of a behavioral response that may affect vital functions, or cause TTS or PTS of beluga whales. If a beluga whale is observed approaching or entering the Level B harassment zone, in-water pile installation and removal will be halted or delayed, and will not commence or resume until either the whale has voluntarily left and been visually confirmed beyond the shutdown zone and on a path away from such zone or 30 minutes have passed without subsequent detections. This will decrease the likelihood of exposing belugas to noise at received levels that could cause Level B harassment, disturbance, or stress. Additionally, the mitigation measures reduce the likelihood of restricting belugas from passing by the POA, as pile driving will not occur if belugas are observed traveling into or out of Knik Arm, or appear likely to do so. Exposure to Level B thresholds are expected to be short in duration, if exposure occurs at all.

Based on the best information currently available, we do not expect that the proposed action will result in serious injury or mortality of any belugas, and none is authorized. Further, we do not expect the effects of the action to alter the physiology, behavioral ecology, or social dynamics of individual whales in ways or to a degree that would reduce their fitness, nor will the proposed action be linked to a reduction in the Cook Inlet beluga whale population. Based on this, NMFS concludes that the proposed action is not expected to appreciably reduce the likelihood of survival or recovery of Cook Inlet beluga whales.

As mentioned in the Environmental Baseline section, Cook Inlet beluga whales may be impacted by a number of anthropogenic activities present in Cook Inlet. The high degree of human activity, especially within upper Cook Inlet, has produced a number of anthropogenic risk factors that marine mammals must contend with. Coastal development and boat traffic, especially near Anchorage, has the potential to disrupt beluga whale behavior, and may alter movements among important summer habitat through acoustic disruption. Seismic exploration in upper Cook Inlet has exposed Cook Inlet beluga whales to sound above the Level A injury and Level B harassment thresholds. Aircraft circling overhead have been observed to cause behavioral changes in groups of Cook Inlet beluga whales, disrupting breathing patterns and possibly feeding activities. Pollution and contaminants were listed as a low relative concern for impeding the recovery of Cook Inlet beluga whales (NMFS 2016b). Currently, there is not a subsistence harvest and direct human-caused mortality due to fisheries bycatch, vessel strikes, or other sources has not been definitively determined (Muto et al. 2022). Belugas have been documented with scars due to vessel strikes and entanglements in ropes and lines, indicating these sources are a potential cause of injury or mortality (McGuire et al. 2020). Anthropogenic noise remains a potential threat of high concern regarding the recovery of Cook Inlet belugas (NMFS 2016b). These risk factors are in addition to those operating on a larger scale such as predation, prey availability, disease, and climate change. The species may be affected by multiple threats at any given time, compounding the impacts of the individual threats. All of these activities are expected to continue to occur into the foreseeable future.

8.2 Mexico and Western North Pacific DPS Humpback Whales

Based on the results of the exposure analysis, we expect four humpback whales may be exposed to noise from pile driving; 11 percent are expected to be from the Mexico DPS and 1 percent are expected to be from the WNP DPS, for exposure of 1 ESA-listed humpback to pile driving sound capable of causing harassment.

Upper Cook Inlet is not regularly used by humpback whales, which is the strongest evidence supporting the conclusion that the proposed action will likely have minimal impact on humpback whale populations or individuals.

Exposure to project-related vessel noise and risk of vessel strike may occur, but adverse effects from vessel disturbance and noise are likely to be insignificant due to the small marginal increase in such activities relative to the environmental baseline, the transitory nature of project-related vessel traffic, and the likely habituation of marine mammals that frequent this heavily trafficked area. Adverse effects from vessel strikes are considered extremely unlikely because of the few additional vessels introduced by the action, slow speeds at which these vessels will operate, rarity of humpbacks in the area, existing regulations regarding approaching humpback whales, and the 100 m shutdown zone that will be implemented.

Disturbance to seafloor, habitat, and prey resources, as well as any trash or pollution from the action, are not expected to adversely affect humpback whales because these disturbances are temporary, and the action area is not important habitat to humpback whales for foraging, migrating, breeding, or other essential life functions. Mitigation measures and adherence to Clean Water Act regulations are expected to minimize the risk of exposure of humpback whales to the potential introduction of pollutants into the action area.

It is difficult to estimate the behavioral responses, if any, that humpback whales in the action area may exhibit to underwater sounds generated by project activities. Though the sounds produced during project activities may not greatly exceed levels that humpbacks already experience in Cook Inlet, some of the sources proposed for use in this project are not among sounds to which they are commonly exposed. The most likely responses from humpback whales to noise from pile driving activities include brief startle reactions or short-term behavioral modification. These reactions are expected to subside quickly when the exposure to pile driving noise ceases. The primary mechanism by which the behavioral changes we have discussed affect the fitness of individual animals is through the animals' energy and time budget. Large whales such as humpbacks have an ability to survive for months on stored energy during migration and while in their wintering areas, and their feeding patterns allow them to acquire energy at high rates. The individual and cumulative energy costs of the behavioral responses we have discussed are not likely to measurably increase energetic costs of humpback whales, and their probable exposure to project-related noise is not likely to reduce their fitness.

The implementation of mitigation measures (including shutdown zones) to reduce exposure to high levels of sound decrease the likelihood of a behavioral response that may affect vital functions, or cause TTS or PTS of humpback whales. Based on the best information currently available, the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of Mexico or WNP DPS humpback whales.

As mentioned in the Environmental Baseline section, Mexico and WNP DPS humpback whales may be impacted by a number of anthropogenic activities present in Cook Inlet. The high degree of human activity, especially within upper Cook Inlet, has produced a number of anthropogenic risk factors that marine mammals must contend with, including: coastal and marine development, oil and gas development, ship strikes, noise pollution, water pollution, prey reduction, fisheries, tourism, and research. These risk factors are in addition to those operating on a larger scale such as predation, disease, and climate change. The species may be affected by multiple threats at any given time, compounding the impacts of the individual threats. All of these activities are expected to continue to occur into the foreseeable future.

8.3 Western DPS Steller Sea Lion Risk Analysis

Based on the results of the exposure analysis, we expect nine Western DPS Steller sea lions may be exposed to noise from pile driving. Upper Cook Inlet is not known to be highly utilized by Steller sea lions, which is the strongest evidence supporting the conclusion that the proposed action will likely have minimal impact on the Western DPS Steller sea lion population.

Exposure to vessel noise and presence, marine debris, seafloor disturbance and turbidity, and small oil spills may occur, but such exposure would have a very small impact, and we conclude that these stressors will not result in take of Steller sea lions. The increase in ship traffic due to the proposed action is unlikely to result in a vessel strike. Project vessels will be traveling at slow speeds, the increase in vessel traffic will be small, and vessel strike is not considered a significant concern for Steller sea lions (only four reports of potential vessel strikes involving Steller sea lions have been reported in Alaska).

Exposure to non-biodegradable marine debris, specifically to debris that can cause entanglement, remains an unquantifiable risk, but associated effects from this project would be minimal. Any increases in turbidity or seafloor disturbance would be temporary, localized, and minimal. Based on the localized nature of small oil spills, the relatively rapid weathering expected, and the safeguards in place to avoid and minimize oil spills, we conclude that the probability of the proposed action causing a small oil spill and exposing Western DPS Steller sea lions is extremely small, and thus the effects are considered highly unlikely to occur. Mitigation measures and adherence to Clean Water Act regulations are expected to minimize the risk of exposure of Steller sea lions to the potential introduction of pollutants into the action area.

It is difficult to estimate the behavioral responses, if any, that Western DPS Steller sea lions in the action area may exhibit to underwater sounds generated by project activities. Though the sounds produced during project activities may not greatly exceed levels that Steller sea lions already experience in Cook Inlet, some of the sources proposed for use in this project are not among sounds to which they are commonly exposed. In response to project-related sounds, some Steller sea lions may move out of the area or change from one behavioral state to another, while other Steller sea lions may exhibit no apparent behavioral changes at all. Potential reactions are expected to subside quickly when the exposure to pile driving noise ceases.

The primary mechanism by which the behavioral changes may affect the fitness of individual animals is through the animal’s energy budget, time budget, or both. Most adult Steller sea lions occupy rookeries during the pupping and breeding season, which extends from late May to early July (NMFS 2008b). The closest major rookery or haulout is over 200 km away from the project site. The individual and cumulative energy costs of the behavioral responses we have discussed are not likely to measurably reduce the energy reserves of Steller sea lions in the action area.

The probable responses (i.e., tolerance, avoidance, short-term masking, and short-term vigilance behavior) to close approaches by vessel operations and their probable exposure to noise from pile driving are not likely to reduce the current or expected future reproductive success or reduce the rates at which Steller sea lions grow, mature, or become reproductively active. Therefore, these exposures are not likely to reduce the abundance, reproduction rates, or survival and growth rates of the population those individuals represent.

Noise from pile driving is likely to cause some individual Steller sea lions to experience changes in their behavioral states that may have adverse consequences (Frid and Dill 2002). However, these responses are not likely to alter the physiology, behavioral ecology, or social dynamics of individual Steller sea lions in ways or to a degree that would reduce their fitness.

The implementation of mitigation measures (including shutdown zones) to reduce exposure to high levels of sound decrease the likelihood of a behavioral response that may affect vital functions, or cause TTS or PTS of Steller sea lions. Based on the best information currently available, the proposed action is not expected to appreciably reduce the likelihood of survival or recovery of Western DPS Steller sea lions.

As mentioned in the Environmental Baseline section, Western DPS Steller sea lions may be impacted by a number of anthropogenic activities present in Cook Inlet. The high degree of human activity, especially within upper Cook Inlet, has produced a number of anthropogenic risk factors that marine mammals must contend with, including: coastal and marine development, oil and gas development, ship strikes, noise pollution, water pollution, prey reduction, fisheries, tourism, and research. These risk factors are in addition to those operating on a larger scale such as predation, disease, and climate change. The species may be affected by multiple threats at any given time, compounding the impacts of the individual threats. All of these activities are expected to continue to occur into the foreseeable future.

As we discussed in the Approach to the Assessment section of this opinion, an action that is not likely to reduce the fitness of individuals would not be likely to reduce the viability of the populations those individuals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of such populations). For this project, we do not expect that the sound created by pile driving will reduce the fitness of any individual marine mammals. An action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise; in this case, the Cook Inlet beluga whale, Mexico and WNP DPS humpback whale, and Western DPS Steller sea lion. As a result, the proposed action is not likely to appreciably reduce the likelihood of the Cook Inlet beluga, Mexico or WNP DPS humpback whale, or Western DPS Steller sea lion 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 Cook Inlet beluga whales, Mexico or Western North Pacific DPS humpback whales, or Western DPS Steller sea lions or to destroy or adversely modify designated Cook Inlet beluga whale critical habitat.

10. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species unless there is a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. § 1532(19)). "Incidental take" is defined as take that results from, but is not the purpose of, the carrying out of an otherwise lawful activity conducted by the action agency or applicant (50 CFR § 402.02). Based on NMFS guidance, the term "harass" under the ESA means to: "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016). The MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (16 U.S.C. § 1362(18)(A)(i) and (ii)). For this consultation, it is expected that take of Cook Inlet beluga whales, Mexico or WNP DPS humpback whales, or Western DPS Steller sea lions will be by harassment. No take due to harm (analogous to MMPA Level A take) is expected or authorized in this biological opinion.

The ESA does not prohibit the take of threatened species unless special regulations have been promulgated, pursuant to ESA section 4(d), to promote the conservation of the species. Federal regulations promulgated pursuant to section 4(d) of the ESA extend the section 9 prohibitions to the take of Mexico DPS humpback whales (81 FR 62260; September 8, 2016) (50 C.F.R. § 223.213).

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 (ITS) and the exemption from section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here**. Absent such authorization, this incidental take statement is inoperative.

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. NMFS Permits Division and USACE have a continuing duty to regulate the activities covered by this ITS. In order to monitor the impact of incidental take, the POA must monitor and 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 NMFS Permits Division and USACE (1) fail to require the permit holder to adhere to the terms and conditions of the ITS through enforceable terms that are added to the authorization, and/or (2) fail to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

10.1 Amount or Extent of Take

Section 7 regulations require NMFS to estimate the number of individuals that may be taken by the proposed actions or utilize a surrogate (e.g., other species, habitat, or ecological conditions) if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (50 CFR § 402.14(i)(1); see also 80 FR 26832; May 11, 2015).

NMFS is reasonably certain the proposed activities for the NES1 project at the POA are likely to result in the incidental take of ESA-listed species by Level B harassment associated with noise from pile driving. The taking by serious injury or death is prohibited and will result in the modification, suspension, or revocation of the ITS. Table 19 lists the amount and timing of authorized take for this action. The method for estimating the number of listed species exposed to sound levels expected to result in Level B harassment is described in Section 6.2.

NMFS expects that 72 instances of Level B harassment of Cook Inlet beluga whales may occur. NMFS expects that four instances of Level B harassment of humpback whales may occur. While we are only authorizing take of one Mexico or WNP DPS humpback whale under the ESA, we will consider the ESA-authorized take limit to be exceeded when the MMPA-authorized limit on Level B take of humpback whales is exceeded, as it is often impracticable to distinguish between humpback whale DPSs in the field. NMFS expects that nine instances of Level B harassment of Western DPS Steller sea lions may occur.

Pile driving activities will be halted as soon as possible when it appears a beluga whale is approaching the Level B zone, or when a humpback whale or Steller sea lion is approaching the Level A shutdown zone and before it reaches the Level A isopleth. No Level A take of ESA-listed marine mammals is authorized in this biological opinion.

Table 19. Incidental take of ESA-listed species authorized.

Species	Total Amount of Take		Duration Across which Take Will Occur
	Level A	Level B	
Cook Inlet beluga whale	0	72	12 Months
Humpback whale Mexico and WNP DPS	0	1	
Western DPS Steller sea lion	0	9	

10.2 Effect of the Take

In Section 9 of this opinion, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Although the biological significance of the expected behavioral responses of Cook Inlet beluga whales, Mexico DPS humpback whales, WNP DPS humpback whales, and Western DPS Steller sea lions remains unknown, this consultation has assumed that exposure to disturbances associated with the POA NES1 pile driving and construction activities 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 measurably affect the reproduction, survival, or recovery of these species. The taking of Cook Inlet beluga whales, Mexico DPS humpback whales, WNP DPS humpback whales, and Western DPS Steller sea lions will be by incidental acoustic harassment only (analogous to MMPA Level B take via behavioral disturbance or temporary threshold shift in their hearing).

10.3 Reasonable and Prudent Measures

“Reasonable and prudent measures” are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take.” (50 CFR 402.02). Failure to comply with RPMs (and the terms and conditions that implement them) may invalidate the take exemption and result in unauthorized take.

RPMs are distinct from the mitigation measures that are included in the proposed action (described in Section 2.1.2). We presume that the mitigation measures will be implemented as described in this opinion. The failure to do so will constitute a change to the action that may require reinitiation of consultation pursuant to 50 CFR § 402.16.

The RPMs included below, along with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. NMFS concludes that the following RPMs are necessary and appropriate to minimize or to monitor the incidental take of Cook Inlet beluga whales, Mexico and WNP DPS humpback whales, and Western DPS Steller sea lions resulting from the proposed action.

- The NMFS Permits Division, USACE, and POA must monitor and report all authorized and unauthorized takes, and monitor and report the effectiveness of mitigation measures incorporated as part of the proposed authorization for the incidental taking of ESA-listed marine mammals pursuant to section 101(a)(5)(D) of the MMPA. In addition, they must submit a report to NMFS AKR that evaluates the mitigation measures and reports the results of the monitoring program.

10.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. These terms and conditions are in addition to the mitigation measures included in the proposed action, as set forth in Section 2.1.2 of this opinion. The NMFS Permits Division and USACE or any applicant has 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(i)(3))).

Any taking that is in compliance with these terms and conditions is not prohibited under the ESA (50 CFR § 402.14(i)(5)). As such, partial compliance with these terms and conditions may invalidate this take exemption and result in unauthorized, prohibited take under the ESA. If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the action may lapse.

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 the RPM, NMFS Permits Division, USACE, or POA must:

- Provide NMFS AKR with written and photographic (if applicable) documentation of any effects of the proposed actions on listed marine mammals and implementation of the mitigation measures specified in Section 2.1.2 of the biological opinion.

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 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).

NMFS recommends the POA:

- Collect acoustic measurements of underwater sound generated by pile splitting, hydraulic shears, and ultrathermic cutting torches in situ and report results of RMS acoustic measures to NMFS AKR
- Coordinate with NMFS AKR on outreach materials such as signage for placement at City of Anchorage owned coastal sites, e.g., the Ship Creek Small Boat Harbor and Point Woronzof, highlighting the endangered status of Cook Inlet beluga whales, the need to properly dispose of all trash, and to maintain a distance of 100 yards from all marine mammals
- Participate as a partner in the annual Belugas Count! event
- Participate in the Alaska Beluga Monitoring Program

In order to keep NMFS's Protected Resources Division informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the POA 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 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 (50 CFR § 402.14(i)(4)).

13. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act (DQA)) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

13.1 Utility

This document records the results of an interagency consultation. The information presented in this document is useful to NMFS Permits Division, USACE, 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 https://www.fisheries.noaa.gov/tags/section-7-consultation. The format and name adhere to conventional standards for style.

13.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

13.3 Objectivity

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the ESA Consultation Handbook, ESA Regulations, 50 CFR § 402.01 et seq.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the literature cited section. The analyses in this opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA implementation, and reviewed in accordance with Alaska Region ESA quality control and assurance processes.

14. REFERENCES

61 North Environmental. 2021. 2020 Petroleum and Cement Terminal Construction Marine Mammal Monitoring Final Report. Report prepared by 61 North Environmental for Pacific Pile and Marine and the Port of Alaska, Anchorage, AK.

61 North Environmental. 2022a. 2021 Petroleum and Cement Terminal Construction Marine Mammal Monitoring Final Report. Report prepared by 61 North Environmental for Pacific Pile and Marine and the Port of Alaska, Anchorage, AK.

61 North Environmental. 2022b. 2022 Port of Alaska PCT/SFD dredging marine mammal monitoring. Report prepared by 61 North Environmental for Pacific Pile and Marine and the Port of Alaska, Anchorage, Alaska.

61 North Environmental. 2022c. 2022 Port of Alaska South Float Dock construction marine mammal monitoring. Report prepared by 61 North Environmental for Pacific Pile and Marine and the Port of Alaska, Anchorage, AK.

Abookire, A. A., and J. F. Piatt. 2005. Oceanographic conditions structure forage fishes into lipid-rich and lipid-poor communities in lower Cook Inlet, Alaska, USA. Marine Ecology Progress Series **287**:229-240.

ABR. 2017. Protected-Species Monitoring Report. 2017 Ship Creek Boat Launch Repairs Project, Anchorage, Alaska. Final Report Prepared for R & M Consultants, Inc. 17+pp.

ADEC. 2019. Alaska Pollutant Discharge Elimination System Permit Fact Sheet. Page 65 *in* W. D. A. Program, editor.

Aguilar, A., and A. Borell. 1994. Reproductive transfer and variation of body load of organochlorine pollutants with age in fin whales (Balaenoptera physalus). Arch. Environ. Contain. Toxicol. **27**:546-554.

Alaska Department of Natural Resources. 2014. Division of Oil and Gas: 2014 Annual Report. Juneau, AK.

Anderson, P. J., and J. F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Marine Ecology Progress Series **189**:117-123.

Atwood, T. C., E. Peacock, M. A. McKinney, K. Lillie, R. Wilson, D. C. Douglas, S. Miller, and P. Terletzky. 2016. Rapid environmental change drives increased land use by an Arctic marine predator. PLoS One **11**:e0155932.

Au, W. W. L. 2000. Hearing in whales and dolphins: An overview. Pages 1-42 *in* W. W. L. Au, A. N. Popper, and R. R. Fay, editors. Hearing by Whales and Dolphins. Springer-Verlag, New York.

Au, W. W. L., D. A. Carder, R. H. Penner, and B. L. Scronce. 1985. Demonstration of adaptation in beluga whale echolocation signals Journal of the Acoustical Society of America **77**:726-730.

Au, W. W. L., A. A. Pack, M. O. Lammers, L. M. Herman, M. H. Deakos, and K. Andrews. 2006. Acoustic properties of humpback whale songs. Journal of the Acoustical Society of America **120**:1103-1110.

Austin, M. E., S. Denes, J. MacDonnell, and G. Warner. 2016. Hydroacoustic Monitoring Report: Anchorage Port Modernization Project Test Pile Program, version 3.0,. Technical report by JASCO Applied Sciences for Kiewit Infrastructure West Co. under Contract PSA 2572., Anchorage, AK.

Awbrey, F. T., J. A. Thomas, and R. A. Kastelein. 1988. Low-frequency underwater hearing sensitivity in belugas, *Delphinapterus leucas*. Journal of the Acoustical Society of America **84**:2273-2275.

Ban, S. S. 2005. Modelling and characterization of Steller sea lion haulouts and rookeries using oceanographic and shoreline type data. University of British Columbia, Vancouver, BC.

Barbeaux, S. J., K. Holsman, and S. Zador. 2020. Marine heatwave stress test of ecosystem-based fisheries management in the Gulf of Alaska Pacific Cod Fishery. Frontiers in Marine Science **7**:703.

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology **78**:535-546.

Barnett, H. K., T. P. Quinn, M. Bhuthimethee, and J. R. Winton. 2020. Increased prespawning mortality threatens an integrated natural-and hatchery-origin sockeye salmon population in the Lake Washington Basin. Fisheries Research **227**:105527.

Barrett-Lennard, L. G., K. Heise, E. Saulitis, G. Ellis, and C. Matkin. 1995. The Impact of Killer Whale Predation on Steller Sea Lion Populations in British Columbia and Alaska. University of British Columbia.

Barrie, L. A., D. Gregor, B. Hargrave, R. Lake, D. Muir, R. Shearer, B. Tracy, and T. Bidleman. 1992. Arctic contaminants: sources, occurrence and pathways. The Science of the Total Environment **122**:1-74.

Bates, N. R., J. T. Mathis, and L. W. Cooper. 2009. Ocean acidification and biologically induced seasonality of carbonate mineral saturation states in the western Arctic Ocean. Journal of Geophysical Research **114**.

Becker, P. R., M. M. Krahn, E. A. Mackey, R. Demiralp, M. M. Schantz, M. S. Epstein, M. K. Donais, B. J. Porter, D. C. G. Muir, and S. A. Wise. 2000. Concentrations of Polychlorinated Biphenyls (PCB's), Chlorinated Pesticides, and Heavy Metals and Other Elements in Tissues of Belugas, Delphinapterus leucas, from Cook Inlet. Marine

Fisheries Review **62**:81-98.

Becker, P. R., J. Kucklick, J. Houget, J. Keller, J. Reiner, R. Day, and E. A. Mackey. 2010. Current-Use and legacy persistent pollutants in the Cook Inlet beluga whales: results for the analysis of banked tissues from the Alaska Marine Mammal Tissue Archival Project (AMMTAP). Cook Inlet Beluga Whale Science Conference, Anchorage, Alaska.

Bettridge, S., C. S. Baker, J. Barlow, P. Clapham, M. Ford, D. Gouveia, D. Mattila, R. Pace, P. E. Rosel, G. K. Silber, and P. Wade. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act. Page 263 p. U.S. Dept. Commer., NOAA, NMFS, SWFSC.

Blackwell, S. B., and C. R. Greene, Jr. 2003. Acoustic measurements in Cook Inlet, Alaska during August 2001. Report 271-2 prepared for National Marine Fisheries Service under contract number 40HANF100123, Greenridge Sciences, Inc., Aptos and Santa Barbara, CA.

Blane, J. M., and R. Jaakson. 1994. The impact of ecotourism boats on the St Lawrence beluga whales. Environmental Conservation **21**:267-269.

BOEM. 2012. Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017. Final Programmatic Environmental Impact Statement. Pages 2,057 p. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Herndon, VA.

BOEM. 2016. Cook Inlet Planning Area, Oil and Gas Lease Sale 244. Final Environmental Impact Statement.

BOEM. 2017. Final biological assessment for oil and gas activities associated with Lease Sale 244. U.S. Dept. of Interior, Bureau of Ocean Energy Management, Alaska OCS Region.

Boman, K. 2012. Apache deploying wireless seismic technology in Alaska's Cook Inlet. Rigzone.com.

Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophysical Research Letters **42**:3414-3420.

Brenner, R. E., A. R. Munro, and S. J. Larsen. 2019. Run Forecasts and Harvest Projections for 2019 Alaska Salmon Fisheries and Review of the 2018 Season. Anchorage, Alaska.

Brett, J. R. 1971. Energetic responses of salmon to temperature. A study of some thermal relations in the physiology and freshwater ecology of sockeye salmon (Oncorhynchus nerkd). American zoologist **11**:99-113.

Brower, A. A., J. T. Clarke, and M. C. Ferguson. 2018. Increased sightings of subArctic cetaceans in the eastern Chukchi Sea, 2008–2016: population recovery, response to climate change, or increased survey effort? Polar Biology **41**:1033-1039.

Bryant, M. 2009. Global climate change and potential effects on Pacific salmonids in freshwater ecosystems of southeast Alaska. Climatic Change **95**:169-193.

Burek, K. A., F. Gulland, and T. M. O'Hara. 2008. Effects of climate change on Arctic marine mammal health. Ecological Applications **18**:S126-S134.

Burgess, W. C. 2014. Ambient underwater sound levels measured at Windy Corner, Turnagain Arm, Alaska. Greeneridge Sciences, Inc. prepared for LGL Alaska Research Associates, Inc., Anchorage, AK.

Burkanov, V. N., and T. R. Loughlin. 2005. Distribution and abundance of Steller sea lions, *Eumetopias jubatus*, on the Asian coast, 1720's-2005. Marine Fisheries Review **67**:1-62.

Burns, J. J., and G. A. Seaman. 1986. Investigations of belukha whales in coastal waters of western and northern Alaska II. Biology and ecology. OCSEAP Final Report 56(1988).

Calkins, D. G. 1989. Status of beluga whales in Cook Inlet. Pages 109-112 Gulf of Alaska, Cook Inlet, and North Aleutian Basin Information Update Meeting, Anchorage, Alaska.

Calkins, D. G., and E. Goodwin. 1988. Investigation of the declining sea lion population in the Gulf of Alaska. Page 76 p. Alaska Dept. of Fish and Game, Anchorage, AK.

Calkins, D. G., and K. W. Pitcher. 1982. Population assessment, ecology and trophic relationships of Steller sea lions in the Gulf of Alaska. Pages 447-546 Environmental assessment of the Alaska continental shelf. Prepared by the Alaska Department of Fish and Game for the Outer Continental Shelf Environmental Assessment Program, Final Report: Research Unit 243, ACE 8094521, Anchorage, AK.

Call, K. A., and T. R. Loughlin. 2005. An ecological classification of Alaskan Steller sea lion (*Eumetopias jubatus*) rookeries: A tool for conservation/management. Fisheries Oceanography **14**:212-222.

CalTrans. 2020. Technical guidance for the assessment of hydroacoustic effects of pile driving on fish: Appendix I – Compendium of pile driving sound data. Report Number: CTHWANP-RT-20-365.01.04, Division of Environmental Analysis, California Department of Transportation, Sacramento, CA.

Casper, B. M., A. N. Popper, F. Matthews, T. J. Carlson, and M. B. Halvorsen. 2012. Recovery of barotrauma injuries in Chinook salmon, *Oncorhynchus tshawytscha* from exposure to pile driving sound. PLoS One **7**:e39593.

Castellote, M., T. A. Mooney, L. Quakenbush, R. Hobbs, C. Goertz, and E. Gaglione. 2014. Baseline hearing abilities and variability in wild beluga whales (*Delphinapterus leucas*). Journal of Experimental Biology **217**:1682-1691.

Castellote, M., R. J. Small, M. O. Lammers, J. J. Jenniges, J. Mondragon, and S. Atkinson. 2016a. Dual instrument passive acoustic monitoring of belugas in Cook Inlet, Alaska.

Journal of the Acoustical Society of America **139**:2697-2707.

Castellote, M., R. J. Small, J. Mondragon, J. Jenniges, and J. Skinner. 2015. Seasonal distribution and foraging behavior of Cook Inlet belugas based on acoustic monitoring. ADFG Final Report to Department of Defense.

Castellote, M., R. J. Small, J. Mondragon, J. Jenniges, and J. P. Skinner. 2016b. Seasonal distribution and foraging behavior of Cook Inlet belugas based on acoustic monitoring. Alaska Department of Fish and Game, Final Wildlife Research Report, ADF&G/DWS/WRR-2016-3. Juneau, AK.

Cavole, L. M., A. M. Demko, R. E. Diner, A. Giddings, I. Koester, C. M. Pagniello, M.-L. Paulsen, A. Ramirez-Valdez, S. M. Schwenck, and N. K. Yen. 2016. Biological impacts of the 2013–2015 warm-water anomaly in the Northeast Pacific: winners, losers, and the future. Oceanography **29**:273-285.

Chapin, F. S., III, S. F. Trainor, P. Cochran, H. Huntington, C. Markon, M. McCammon, A. D. McGuire, and M. Serreze. 2014. Ch. 22: Alaska. Pages 514-536 *in* J. M. Melillo, T. C. Richmond, and G. W. Yohe, editors. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program.

Cheng, L., J. Abraham, J. Zhu, K. E. Trenberth, J. Fasullo, T. Boyer, R. Locarnini, B. Zhang, F. Yu, L. Wan, X. Chen, X. Song, Y. Liu, and M. E. Mann. 2020. Record-setting ocean warmth continued in 2019. Advances in Atmospheric Sciences **37**:137-142.

Chitre, M., S. H. Ong, and J. Potter. 2005. Performance of coded OFDM in very shallow water channels and snapping shrimp noise. Pages 996-1001. IEEE.

Chu, K., C. Sze, and C. Wong. 1996. Swimming behaviour during the larval development of the shrimp *Metapenaeus ensis* (De Haan, 1844)(Decapoda, Penaeidae). Crustaceana **69**:368-378.

Chumbley, K., J. Sease, M. Strick, and R. Towell. 1997. Field studies of Steller sea lions (*Eumetopias jubatus*) at Marmot Island, Alaska 1979 through 1994. Page 99 p. U.S. Dept. of Commerce, NOAA, NMFS, Alaska Fisheries Science Center, Seattle, WA.

Clapham, P. J. 1992. Age at attainment of sexual maturity in humpback whales, *Megaptera novaeangliae*. Canadian Journal of Zoology **70**:1470-1472.

Clapham, P. J. 1993. Social organization of humpback whales on a North Atlantic feeding ground. Pages 131-145.

Clark, C. W., W. T. Ellison, B. L. Southall, L. Hatch, S. M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. Marine Ecology Progress Series **395**:201-222.

Colbeck, G. J., P. Duchesne, L. D. Postma, V. Lesage, M. O. Hammill, and J. Turgeon. 2013.

Groups of related belugas (*Delphinapterus leucas*) travel together during their seasonal migrations in and around Hudson Bay. Proceedings of the Royal Society B: Biological Sciences **280**:20122552.

Cornick, L. A., and D. J. Seagars. 2016. Final Report Anchorage Port Modernization Project Test Pile Program.

Costa, D. P., D. E. Crocker, J. Gedamke, P. M. Webb, D. S. Houser, S. B. Blackwell, D. Waples, S. A. Hayes, and B. J. L. Boeuf. 2003. The effect of a low-frequency sound source (acoustic thermometry of the ocean climate) on the diving behavior of juvenile northern elephant seals, Mirounga angustirostris. The Journal of the Acoustical Society of America **113**:1155-1165.

Cox, T. M., T. Ragen, A. Read, E. Vos, R. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, and L. Crum. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management **7**:177-187.

Crespi, E. J., T. D. Williams, T. S. Jessop, and B. Delehanty. 2013. Life history and the ecology of stress: how do glucocorticoid hormones influence life-history variation in animals? Functional Ecology **27**:93-106.

D'Vincent, C. G., R. M. Nilson, and R. E. Hanna. 1985. Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska. Scientific Reports of the Whales Research Institute **36**:41–47.

de Swart, R. L., P. S. Ross, J. G. Vos, and A. D. Osterhaus. 1996. Impaired immunity in harbour seals *(Phoca vitulina*) exposed to bioaccumulated environmental contaminants: review of a long-term feeding study. Environmental Health Perspectives **104**:823-828.

DeGrandpre, M., W. Evans, M.-L. Timmermans, R. Krishfield, B. Williams, and M. Steele. 2020. Changes in the Arctic Ocean carbon cycle with diminishing ice cover. Geophysical Research Letters **47**:e2020GL088051.

Delean, B. J., V. T. Helker, M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, J. Jannot, and N. C. Young. 2020. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks 2013-2017. Page 86 p. U. S. Dept. of Commerce, NOAA, NMFS, Alaska Fisheries Science Center, Seattle, WA.

Denes, S. L., and M. Austin. 2016. Drilling sound source characterization, Furie 2016, Kitchen Lights Unit, Cook Inlet, AK. Report P001256, Document 01243 Version 2.0, Report prepared by JASCO Applied Sciences for Jacobs Engineering Group, Inc., for Furie Operating Alaska, Contract 05DK1602-S15-0005, Anchorage, AK.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate change impacts on marine ecosystems. Annual

Reviews in Marine Science **4**:11-37.

Dueñas, M.-A., H. J. Ruffhead, N. H. Wakefield, P. D. Roberts, D. J. Hemming, and H. Diaz-Soltero. 2018. The role played by invasive species in interactions with endangered and threatened species in the United States: a systematic review. Biodiversity and Conservation:1-13.

Dunlop, R. A., D. H. Cato, and M. J. Noad. 2014. Evidence of a Lombard response in migrating humpback whales (Megaptera novaeangliae). The Journal of the Acoustical Society of America **136**:430-437.

Easley-Appleyard, B., and K. E. Leonard. 2022. NMFS Port of Alaska visual monitoring project report. Page 42 p. U.S. Dept. of Commerce, NOAA, NMFS, Alaska Region, Protected Resources Division, Anchorage, AK.

Eickmeier, J., and J. Vallarta. 2022. Estimation of high-frequency auditory masking in beluga whales by commercial vessels in Cook Inlet, Alaska. Transportation Research Record:1-9.

Eisner, L. B., Y. I. Zuenko, E. O. Basyuk, L. L. Britt, J. T. Duffy-Anderson, S. Kotwicki, C. Ladd, and W. Cheng. 2020. Environmental impacts on walleye pollock (*Gadus chalcogrammus*) distribution across the Bering Sea shelf. Deep Sea Research Part II: Topical Studies in Oceanography **181-182**:104881.

Ellison, W., B. Southall, C. Clark, and A. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology **26**:21-28.

EPA. 2015. Permit No. AKG 28 5100. Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES) for Oil and Gas Exploration Facilities in Federal Waters of Cook Inlet.

Erbe, C., R. Dunlop, and S. Dolman. 2018. Effects of noise on marine mammals. Pages 277-309 Effects of anthropogenic noise on animals. Springer.

Eriksson, P., E. Jakobsson, and A. Fredriksson. 1998. Developmental neurotoxicity of brominated flame retardants, polybrominated diphenyl ethers and tetrabromo-bis-phenol A. Organohalogen compounds **35**:375-377.

Everitt, R. D., C. H. Fiscus, and R. L. DeLong. 1980. Northern Puget Sound marine mammals. Interagency energy/environment R&D Program Report No. EPA 600/7-80-139 prepared by the NOAA NMFS National Marine Mammal Laboratory for the Marine Ecosytems Analysis Puget Sound Project, U.S. Dept. of Commerce and U.S. Environmental Protection Agency, Washington, D.C.

Ezer, T., J. R. Ashford, C. M. Jones, B. A. Mahoney, and R. C. Hobbs. 2013. Physical–biological interactions in a subarctic estuary: How do environmental and physical factors impact the movement and survival of beluga whales in Cook Inlet, Alaska? Journal of Marine Systems **111**:120-129.

Fabry, V. J., J. B. McClintock, J. T. Mathis, and J. M. Grebmeier. 2009. Ocean acidification at high latitudes: the Bellweather. Oceanography **22**:160-171.

Fabry, V. J., B. A. Seibel, R. A. Feely, and J. C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. ICES Journal of Marine Science **65**:414-432.

Fair, P. A., and P. R. Becker. 2000. Review of stress in marine mammals. Journal of Aquatic Ecosystem Stress and Recovery **7**:335-354.

Fairweather Science, L. 2020. 2019 Hilcorp Alaska Lower Cook Inlet Seismic Survey Marine Mammal Monitoring and Mitigation Report. Anchorage, AK.

Federal Aviation Administration. 2016. Alaskan Region Aviation Fact Sheet.

Fedewa, E. J., T. M. Jackson, J. I. Richar, J. L. Gardner, and M. A. Litzow. 2020. Recent shifts in northern Bering Sea snow crab (*Chionoecetes opilio*) size structure and the potential role of climate-mediated range contraction. Deep Sea Research Part II: Topical Studies in Oceanography:104878.

Feely, R. A., S. C. Doney, and S. R. Cooley. 2009. Ocean acidification: present conditions and future changes in a high-CO_2 world. Oceanography **22**:37-47.

Feely, R. A., C. L. Sabine, K. Lee, W. Berelson, J. Kleypas, V. J. Fabry, and F. J. Millero. 2004. Impact of anthropogenic CO2 on the CaCO3 system in the oceans. Science **305**:362-366.

Finley, K. J., G. W. Miller, R. A. Davis, and C. R. Greene. 1990. Reactions of belugas, *Delphinapterus leucas*, and narwhals, *Monodon monoceros*, to ice-breaking ships in the Canadian high arctic. Canadian bulletin of fisheries and aquatic sciences/Bulletin canadien des sciences halieutiques et aquatiques.

Finneran, J. J., D. A. Carder, R. Dear, T. Belting, J. McBain, L. Dalton, and S. H. Ridgway. 2005. Pure tone audiograms and possible aminoglycoside-induced hearing loss in belugas (*Delphinapterus leucas*). Journal of the Acoustical Society of America **117**:3936-3943.

Finneran, J. J., R. Dear, D. A. Carder, and S. H. Ridgway. 2003. Auditory and behavioral responses of California sea lions (*Zalophus californianus*) to single underwater impulses from an arc-gap transducer. Journal of the Acoustical Society of America **114**:1667-1677.

Finneran, J. J., C. E. Schlundt, D. A. Carder, J. A. Clark, J. A. Young, J. B. Gaspin, and S. H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (Tursiops truncatus) and a beluga whale (Delphinapterus leucas) to impulsive sounds resembling distant signatures of underwater explosions. The Journal of the Acoustical Society of America **108**:417-431.

Finneran, J. J., C. E. Schlundt, D. A. Carder, and S. H. Ridgway. 2002a. Auditory filter shapes for the bottlenose dolphin (Tursiops truncatus) and the white whale (Delphinapterus leucas) derived with notched noise. The Journal of the Acoustical Society of America **112**:322-328.

Finneran, J. J., C. E. Schlundt, R. Dear, D. A. Carder, and S. H. Ridgway. 2002b. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. The Journal of the Acoustical Society of America **111**:2929-2940.

Fish, J. F., and J. S. Vania. 1971. Killer whale, Orcinus orca, sounds repel white whales, Delphinapterus leucas. Fishery Bulletin **69**:531.

Foote, A. D., R. W. Osborne, and A. R. Hoelzel. 2004. Whale-call response to masking boat noise. Nature **428**:910.

Forney, K. A., B. L. Southall, E. Slooten, S. Dawson, A. J. Read, R. W. Baird, and R. L. Brownell Jr. 2017. Nowhere to go: noise impact assessments for marine mammal populations with high site fidelity. Endangered Species Research **32**:391-413.

Freed, J. C., N. C. Young, B. J. Delean, V. T. Helker, M. M. Muto, K. M. Savage, S. S. Teerlink, L. A. Jemison, K. M. Wilkinson, and J. E. Jannot. 2022. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2016-2020. Page 116 p. U. S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Frid, A., J. Burns, G. G. Baker, and R. E. Thorne. 2009. Predicting synergistic effects of resources and predators on foraging decisions by juvenile Steller sea lions. Oecologia **158**:12.

Frid, A., and L. M. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. 6(1): 11. [online] URL: . Conservation Ecology **6**:1-16.

Frölicher, T. L., E. M. Fischer, and N. Gruber. 2018. Marine heatwaves under global warming. Nature **560**:360-364.

Funk, D. W., R. Rodrigues, D. S. Ireland, and W. R. Koski. 2010. Summary and assessment of potential effects on marine mammals. Pages 11-11 - 11-59 *in* I. D. Funk DW, Rodrigues R, and Koski WR, editor. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008.

Gailey, G., B. Würsig, and T. L. McDonald. 2007. Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, Northeast Sakhalin Island, Russia. Environmental Monitoring and Assessment **134**:75.

Garland, E. C., M. Castellote, and C. L. Berchok. 2015. Beluga whale (*Delphinapterus leucas*) vocalizations and call classification from the eastern Beaufort Sea population. Journal of the Acoustical Society of America **137**:3054-3067.

Geraci, J. R., and D. J. St. Aubin. 1990. Sea Mammals and Oil: Confronting the Risks. Academic Press, Inc., San Deigo, CA.

Gisiner, R. C. 1985. Male territorial and reproductive behavior in the Steller sea lion, *Eumetopias jubatus*. Ph.D. dissertation. University of California, Santa Cruz, CA.

Goetz, K. T., R. A. Montgomery, J. M. Ver Hoef, R. C. Hobbs, and D. S. Johnson. 2012. Identifying essential summer habitat of the endangered beluga whale Delphinapterus leucas in Cook Inlet, Alaska. Endangered Species Research **16**:135-147.

Goetz, K. T., K. E. W. Shelden, C. L. Sims, J. M. Waite, and P. R. Wade. 2023. Abundance of belugas (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2021 and June 2022. Page 47 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Marine Mammal Laboratory, Seattle, WA.

Goldbogen, J. A., J. Calambokidis, D. A. Croll, J. T. Harvey, K. M. Newton, E. M. Oleson, G. Schorr, and R. E. Shadwick. 2008. Foraging behavior of humpback whales: kinematic and respiratory patterns suggest a high cost for a lunge. Journal of Experimental Biology **211**:3712-3719.

Grebmeier, J. M., J. E. Overland, S. E. Moore, E. V. Farley, E. C. Carmack, L. W. Cooper, K. E. Frey, J. H. Helle, F. A. McLaughlin, and S. L. McNutt. 2006. A major ecosystem shift in the northern Bering Sea. Science **311**:1461-1464.

Halvorsen, M. B., B. M. Casper, C. M. Woodley, T. J. Carlson, and A. N. Popper. 2012. Threshold for onset of injury in Chinook salmon from exposure to impulsive pile driving sounds. PLoS One **7**:e38968.

Hansen, D. J. 1985. The Potential Effects of Oil Spills and Other Chemical Pollutants on Marine Mammals Occurring in Alaskan Waters. USDOI, MMS, Alaska OCS Region, Anchorage, AK.

Hare, S. R., and N. J. Mantua. 2000. Empirical evidence for North Pacific regime shifts in 1977 and 1989. Progress in Oceanography **47**:103-145.

Hastings, M. C., and A. N. Popper. 2005. Effects of sound on fish. Report prepared by Jones and Stokes under contract with California Department of Transportation, No. 43A0139, Sacramento, CA.

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. 2019. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. Page 71 p. U. S. Dept. of Commerce, NOAA, NMFS, Alaska Fisheries Science Center, Seattle, WA.

Hildebrand, J. A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series **395**:5-20.

Hinch, S. G., S. J. Cooke, A. P. Farrell, K. M. Miller, M. Lapointe, and D. A. Patterson. 2012. Dead fish swimming: a review of research on the early migration and high premature mortality in adult Fraser River sockeye salmon Oncorhynchus nerka. J Fish Biol **81**:576-599.

Hines, A. H., and G. M. Ruiz. 2000. Marine Invasive species and biodiversity of South Central Alaska. Smithsonian Environmental Research Center.

Hinzman, L. D., N. D. Bettez, W. R. Bolton, F. S. Chapin, M. B. Dyurgerov, C. L. Fastie, B. Griffith, R. D. Hollister, A. Hope, H. P. Huntington, A. M. Jensen, G. J. Jia, T. Jorgenson, D. L. Kane, D. R. Klein, G. Kofinas, A. H. Lynch, A. H. Lloyd, A. D. McGuire, F. E. Nelson, W. C. Oechel, T. E. Osterkamp, C. H. Racine, V. E. Romanovsky, R. S. Stone, D. A. Stow, M. Sturm, C. E. Tweedie, G. L. Vourlitis, M. D. Walker, D. A. Walker, P. J. Webber, J. M. Welker, K. S. Winker, and K. Yoshikawa. 2005. Evidence and implications of recent climate change in northern Alaska and other Arctic regions. Climatic Change **72**:251-298.

Hobbs, R. C., K. L. Laidre, D. J. Vos, B. A. Mahoney, and M. Eagleton. 2005. Movements and area use of belugas, *Delphinapterus leucas*, in a subArctic Alaskan estuary. Arctic **58**:331-340.

Hobbs, R. C., and K. E. W. Shelden. 2008. Supplemental status review and extinction assessment of Cook Inlet belugas (*Delphinapterus leucas*). Page 76 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Hollowed, A. B., and W. S. Wooster. 1992. Variability of Winter Ocean Conditions and Strong Year Classes of Northeast Pacific Groundfish. ICES Marine Science Symposium **195**:433-444.

Holt, M. M., D. P. Noren, V. Veirs, C. K. Emmons, and S. Veirs. 2009. Speaking up: Killer whales (*Orcinus orca*) increase their call amplitude in response to vessel noise. Journal of the Acoustical Society of America **125**:EL27-EL32.

Houghton, J. 2001. The science of global warming. Interdisciplinary Science Reviews **26**:247-257.

Houser, D. S., and J. J. Finneran. 2006. Variation in the hearing sensitivity of a dolphin population determined through the use of evoked potential audiometry. The Journal of the Acoustical Society of America **120**:4090-4099.

Houser, D. S., K. Moore, S. Sharp, J. Hoppe, and J. J. Finneran. 2018. Cetacean evoked potential audiometry by stranding networksenables more rapid accumulation of hearing information instranded odontocetes. Journal of Cetacean Research and Management **18**:93-101.

Huntington, H. P. 2000. Using traditional ecological knowledge in science: methods and applications. Ecological Applications **10**:1270-1274.

Huntington, H. P., S. L. Danielson, F. K. Wiese, M. Baker, P. Boveng, J. J. Citta, A. De Robertis, D. M. Dickson, E. Farley, and J. C. George. 2020. Evidence suggests potential transformation of the Pacific Arctic ecosystem is underway. Nature Climate Change **10**:342-348.

ICRC. 2012. 2011 Annual Marine Mammal Monitoring Report. Construction and Scientific Monitoring Associated with the Port of Anchorage Intermodal Expansion Project, Marine Terminal Redevelopment. Report prepared by Integrated Concepts and Research Corporation for the U.S. Dept. of Transportation and the Port of Anchorage, Anchorage, AK.

IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

IPCC. 2019. Summary for Policymakers. Pages 1-36 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. Weyer, editors. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY.

Isaac, J. L. 2009. Effects of climate change on life history: implications for extinction risk in mammals. Endangered Species Research **7**:115-123.

Jacobs Engineering Group. 2017. Biological evaluation for offshore oil and gas exploratory drilling in the Kitchen Lights Unit of Cook Inlet, Alaska. Prepared for Furie Operating Alaska, LLC., Anchorage, AK.

Jacobs Engineering Group. 2019. 2018 Marine mammal monitoring 90-day report for natural gas well development drilling at the julius R platform Cook Inlet, Alaska. Developed for Furie Operating Alaska, LLC, Anchorage, AK.

Jemison, L. A., G. W. Pendleton, L. W. Fritz, K. K. Hastings, J. M. Maniscalco, A. W. Trites, and T. S. Gelatt. 2013. Inter-population movements of Steller sea lions in Alaska with implications for population separation. PLoS One **8**:e70167.

Jessop, T. S., A. D. Tucker, C. J. Limpus, and J. M. Whittier. 2003. Interactions between ecology, demography, capture stress, and profiles of corticosterone and glucose in a free-living population of Australian freshwater crocodiles. General and comparative endocrinology **132**:161-170.

Jiang, L., R. A. Feely, B. R. Carter, D. J. Greeley, D. K. Gledhill, and K. M. Arzayus. 2015. Climatological distribution of aragonite saturation state in the global oceans. Global Biogeochemical Cycles **29**:1656-1673.

Johnson, C. S., M. W. McManus, and D. Skaar. 1989. Masked tonal hearing thresholds in the beluga whale. Journal of the Acoustical Society of America **85**:2651-2654.

Johnson, J. H., and A. A. Wolman. 1984. The Humpback Whale, *Megaptera novaeangliae*. Marine Fisheries Review **46**:300-337.

Jokela, B., J. Spencer, D. Shelton, D. R. Jones, P. Craig, M. A. Smultea, and J. Plaskett. 2010. Preliminary evaluation of the effects of watewater discharge on Cook Inlet beluga whales. Pages 200-254 *in* Cook Inlet Beluga Whale Science Conference October 11, 2010, Anchorage.

KABATA. 2004. Knik Arm Crossing preliminary offshore water quality assessment. Kinnetic Laboratories, Inc.

Kastelein, R. A., L. Hoek, R. Gransier, M. Rambags, and N. Claeys. 2014. Effect of level, duration, and inter-pulse interval of 1-2 kHz sonar signal exposures on harbor porpoise hearing. Journal of the Acoustical Society of America **136**:412-422.

Kastelein, R. A., R. Van Schie, W. C. Verboom, and D. de Haan. 2005. Underwater hearing sensitivity of a male and a female Steller sea lion (*Eumetopias jubatus*). Journal of the Acoustical Society of America **118**:1820-1829.

Kendall, L. S., and L. A. Cornick. 2015. Behavior and distribution of Cook Inlet beluga whales, *Delphinapterus leucas*, before and during pile driving activity. Marine Fisheries Review **77**:106-115.

Kendall, L. S., K. Lomac-MacNair, G. Campbell, S. Wisdom, and N. Wolf. 2015. SAExploration 2015 Cook Inlet 3D seismic surveys: marine mammal monitoring and mitigation 90-day report. Prepared by Fairweather Science for National Marine Fisheries Service Permits and Conservation Division Office of Protected Resources, Anchorage, AK.

Kendall, L. S., A. Sirovic, and E. H. Roth. 2014. Effects of construction noise on the Cook Inlet beluga whale (*Delphinapterus leucas*) vocal behavior. Canadian Acoustics **41**:3-13.

Keple, A. R. 2002. Seasonal abundance and distribution of marine mammals in the southern Strait of Georgia, British Columbia. University of British Columbia.

Ketten, D. R. 1997. Structure and function in whale ears. Bioacoustics **8**:103-135.

Kight, C. R., and J. P. Swaddle. 2011. How and why environmental noise impacts animals: an integrative, mechanistic review. Ecology Letters **14**:1052-1061.

Kingsley, M. 2002. Cancer rates in St Lawrence belugas; comment on Martineau et al. 1999, cancer in beluga whales. J Cetacean Res Manag. Special:249-265.

Kinnetic Laboratories Incorporated. 2017. Monitoring program annual report January-December 2016, Anchorage water and wastewater utility John M. Asplund water pollution control facility at Point Woronzof. Report prepared by Kinnectic Laboratories for Municipality of Anchorage, Anchorage Water & Wastewater Utility, Anchorage, Alaska.

Klishin, V., V. Popov, and A. Y. Supin. 2000. Hearing capabilities of a beluga whale, Delphinapterus leucas. Aquatic Mammals **26**:212-228.

Koski, W. R., D. W. Funk, D. S. Ireland, C. Lyons, K. Christie, A. M. Macrander, and S. B. Blackwell. 2009. An update on feeding by bowhead whales near an offshore seismic survey in the central Beaufort Sea.

Kryter, K. D. 1970. The effects of noise on man. Academic Press, Inc., New York.

Kryter, K. D. 1985. The handbook of hearing and the effects of noise, 2nd edition. Academic Press, Orlando, FL.

Kucey, L. 2005. Human disturbance and the hauling out behavior of steller sea lions (*Eumetopias jubatus*). University of British Columbia, British Columbia.

Lair, S., L. N. Measures, and D. Martineau. 2015. Pathologic Findings and Trends in Mortality in the Beluga (*Delphinapterus leucas*) Population of the St Lawrence Estuary, Quebec, Canada, From 1983 to 2012. Veterinary Pathology **53**:22-36.

Lambertsen, R. H. 1992. Crassicaudosis: a parasitic disease threatening the health and population recovery of large baleen whales. Rev. Sci. Technol., Off. Int. Epizoot. **11**:1131-1141.

Lammers, M. O., M. Castellote, R. J. Small, S. Atkinson, J. Jenniges, A. Rosinski, J. N. Oswald, and C. Garner. 2013. Passive acoustic monitoring of Cook Inlet beluga whales (Delphinapterus leucas). Journal of the Acoustical Society of America **134**:2497-2504.

Lankford, S., T. Adams, R. Miller, and J. Cech Jr. 2005. The cost of chronic stress: impacts of a nonhabituating stress response on metabolic variables and swimming performance in sturgeon. Physiological and Biochemical Zoology **78**:599-609.

Learmonth, J. A., C. D. Macleod, M. B. Santos, G. J. Pierce, H. Q. P. Crick, and R. A. Robinson. 2006. Potential effects of climate change on marine mammals. Oceanography and Marine Biology: An Annual Review **44**:431-464.

Lefebvre, K. A., L. Quakenbush, E. Frame, K. B. Huntington, G. Sheffield, R. Stimmelmayr, A. Bryan, P. Kendrick, H. Ziel, T. Goldstein, J. A. Snyder, T. Gelatt, F. Gulland, B. Dickerson, and V. Gill. 2016. Prevalence of algal toxins in Alaskan marine mammals foraging in a changing arctic and subarctic environment. Harmful Algae **55**:13-24.

Lesage, V., C. Barrette, M. C. S. Kingsley, and B. Sjare. 1999. The effect of vessel noise on the vocal behavior of belugas in the St. Lawrence River Estuary, Canada. Marine Mammal Science **15**:65-84.

Lischka, S., and U. Riebesell. 2012. Synergistic effects of ocean acidification and warming on overwintering pteropods in the Arctic. Global Change Biology **18**:3517-3528.

Litzow, M. A., K. M. Bailey, F. G. Prahl, and R. Heintz. 2006. Climate regime shifts and reorganization of fish communities: the essential fatty acid limitation hypothesis. Marine Ecology Progress Series **315**:1-11.

Ljungblad, D. K., B. Wursig, S. L. Swartz, and J. M. Keene. 1988. Observations on the behavioral responses of bowhead whales (Balaena mysticetus) to active geophysical vessels in the Alaskan Beaufort Sea. Arctic **41**:183-194.

Lomac-MacNair, K., L. S. Kendall, and S. Wisdom. 2013. Marine mammal monitoring and mitigation 90-day report, May 6-September 30, 2012, Alaska Apache Corporation 3D seismic program, Cook Inlet, Alaska. SAExploration and Fairweather, Anchorage, AK.

Lomac-MacNair, K., M. A. Smultea, M. P. Cotter, C. Thissen, and L. Parker. 2016. Socio-sexual and probable mating behavior of Cook Inlet beluga whales, *Delphinapterus leucas*, observed from an aircraft. Marine Fisheries Review **77**:32-39.

Lomac-MacNair, K., C. Thissen, and M. A. Smultea. 2014. NMFS 90-Day Report for Marine Mammal Monitoring and Mitigation during SAExploration's Colville River Delta 3D Seismic Survey, Beaufort Sea, Alaska, August to September 2014. Report prepared for SAExploration, Inc, by Smultea Environmental Sciences, P.O. Box 256, Preston, WA 98050. December 15, 2014., Preston, WA.

Lopez, J. W., T. B. Parr, D. C. Allen, and C. C. Vaughn. 2020. Animal aggregations promote emergent aquatic plant production at the aquatic-terrestrial interface. Ecology **101**:e03126.

Loughlin, T. R. 2002. Steller's sea lion *Eumetopias jubatus*. Pages 1181-1185 *in* W. F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of marine mammals. Academic Press, San Diego, CA.

Loughlin, T. R., D. J. Rugh, and C. H. Fiscus. 1984. Northern sea lion distribution and abundance: 1956-80. Journal of Wildlife Management **48**:729-740.

Loughlin, T. R., and A. E. York. 2000. An accounting of the sources of Steller sea lion, *Eumetopias jubatus*, mortality. Marine Fisheries Review **62**:40-45.

Lüthi, D., M. Le Floch, B. Bereiter, T. Blunier, J.-M. Barnola, U. Siegenthaler, D. Raynaud, J. Jouzel, H. Fischer, K. Kawamura, and T. F. Stocker. 2008. High-resolution carbon dioxide concentration record 650,000–800,000 years before present. Nature **453**:379-382.

Macleod, C. D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: A review and synthesis. Endangered Species Research **7**:125-136.

Marcogliese, D. J. 2001. Implications of climate change for parasitism of animals in the aquatic environment. Canadian Journal of Zoology **79**:1331-1352.

Martineau, D., S. De Guise, M. Fournier, L. Shugart, C. Girard, A. Lagacé, and P. Béland. 1994. Pathology and toxicology of beluga whales from the St. Lawrence Estuary, Quebec, Canada. Past, present and future. Science of The Total Environment **154**:201-215.

Martineau, D., K. Lemberger, A. Dallaire, P. Labelle, P. Lipscomb Thomas, P. Michel, and I. Mikaelian. 2002. Cancer in wildlife, a case study: beluga from the St. Lawrence estuary, Québec, Canada. Environmental Health Perspectives **110**:285-292.

Martins, E. G., S. G. Hinch, D. A. Patterson, M. J. Hague, S. J. Cooke, K. M. Miller, D. Robichaud, K. K. English, and A. P. Farrell. 2012. High river temperature reduces survival of sockeye salmon (Oncorhynchus nerka) approaching spawning grounds and exacerbates female mortality. Canadian Journal of Fisheries and Aquatic Sciences **69**:330-342.

Maruska, K. P., and A. F. Mensinger. 2009. Acoustic characteristics and variations in grunt vocalizations in the oyster toadfish *Opsanus tau*. Environmental Biology of Fishes **84**:325-337.

Matkin, C. O. 2011. Predation by killer whales in Cook Inlet and Western Alaska: an integrated approach 2008-2009. Project R0303-01 Final Report, Homer, AK.

Mauger, S., R. Shaftel, J. C. Leppi, and D. J. Rinella. 2017. Summer temperature regimes in southcentral Alaska streams: watershed drivers of variation and potential implications for Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences **74**:702-715.

Mayette, A., L. Loseto, T. Pearce, C. A. Hornby, and M. Marcoux. 2022. Group characteristics and spatial organization of the Eastern Beaufort Sea beluga whale (*Delphinapterus leucas*) population using aerial photographs. Canadian Journal of Zoology **100**:363-375.

McCarthy, J. J., O. Canziani, N. A. Leary, D. J. Dokken, and K. S. White. 2001. Climate change 2001: Impacts, adaptation, and vulnerability. Contribution of working group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.

McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: Analysis of airgun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid: report on research conducted for The Australian Petroleum Production and Exploration Association.

McCauley, R. D., J. Fewtrell, and A. N. Popper. 2003. High intensity anthropogenic sound damages fish ears. The Journal of the Acoustical Society of America **113**:638-642.

McGuire, T., and A. Stephens. 2017. Photo-identification of beluga whales in Cook Inlet, Alaska: summary and synthesis of 2005-2015 data. Final Report. LGL Alaska Research Associates, Inc. Prepared for: National Marine Fisheries Service Alaska Region, Protected Resources Division, Anchorage, AK.

McGuire, T., A. Stephens, and L. Bisson. 2014. Photo-identification of Cook Inlet beluga whales in the waters of the Kenai Peninsula Borough, Alaska. Final report of field activities and belugas identified 2011–2013. Kenai Peninsula Borough.

McGuire, T. L., K. E. W. Shelden, G. K. Himes Boor, A. D. Stephens, J. R. McClung, C. Garner, C. E. C. Goertz, K. A. Burek-Huntington, G. O'Corry-Crowe, and B. Wright. 2021. Patterns of mortality in endangered Cook Inlet beluga whales: Insights from pairing a long-term photo-identification study with stranding records. Marine Mammal Science **37**:492-511.

McGuire, T. L., and A. Stephens. 2016. Summary Report: Status of previously satellite tagged Cook Inlet beluga whales. Report prepared by LGL Alaska Research Associates, Inc., Anchorage, AK.

McGuire, T. L., A. D. Stephens, J. R. McClung, C. Garner, K. A. Burek-Huntington, C. E. C. Goertz, K. E. W. Shelden, G. O’Corry-Crowe, G. K. H. Boor, and B. Wright. 2020. Anthropogenic scarring in long-term photo-identification records of Cook Inlet beluga whales, *Delphinapterus leucas*. Marine Fisheries Review **82**:20-40.

McPherson, R., and R. Beebee. 2023. Port of Alaska Technical Memorandum: Concept-level offshore sediment disposal assessment of NES1 material.

McQuinn, I. H., V. Lesage, D. Carrier, G. Larrivée, Y. Samson, S. Chartrand, R. Michaud, and J. Theriault. 2011. A threatened beluga (Delphinapterus leucas) population in the traffic lane: Vessel-generated noise characteristics of the Saguenay-St. Lawrence Marine Park, Canada. The Journal of the Acoustical Society of America **130**:3661-3673.

Melcon, M. L., A. J. Cummins, S. M. Kerosky, L. K. Roche, S. M. Wiggins, and J. A. Hildebrand. 2012. Blue whales respond to anthropogenic noise. PLoS One **7**:e32681.

Merrick, R. L., and T. R. Loughlin. 1997. Foraging behavior of adult female and young-of-the-year Steller sea lions in Alaskan waters. Canadian Journal of Zoology **75**:776-786.

Migura, M., and C. Bollini. 2022. To take or not take? Examination of the status quo process for issuing take authorizations of endangered Cook Inlet beluga whales and implications for their recovery. Conservation Science and Practice **4**:e590.

Miller, G., V. Moulton, R. Davis, M. Holst, P. Millman, A. MacGillivray, and D. Hannay. 2005. Monitoring seismic effects on marine mammals—southeastern Beaufort Sea, 2001-2002. Offshore oil and gas environmental effects monitoring/Approaches and technologies.

Battelle Press, Columbus, OH:511-542.

Moberg, G. P. 2000. Biological response to stress: Implications for animal welfare. Pages 1-21 *in* G. P. Moberg and J. A. Mench, editors. The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare. CABI Publishing, Oxon, United Kingdom.

Mohseni, O., and H. Stefan. 1999. Stream temperature/air temperature relationship: a physical interpretation. Journal of hydrology **218**:128-141.

Molnar, J. L., R. L. Gamboa, C. Revenga, and M. D. Spalding. 2008. Assessing the global threat of invasive species to marine biodiversity. Frontiers in Ecology and the Environment **6**:485-492.

Mooney, T. A., P. E. Nachtigall, M. Castellote, K. A. Taylor, A. F. Pacini, and J.-A. Esteban. 2008. Hearing pathways and directional sensitivity of the beluga whale, Delphinapterus leucas. Journal of Experimental Marine Biology and Ecology **362**:108-116.

Moore, S. E., K. E. Shelden, L. K. Litzky, B. A. Mahoney, and D. J. Rugh. 2000. Beluga, *Delphinapterus leucas*, habitat associations in Cook Inlet, Alaska. Marine Fisheries Review **62**:60-80.

Morton, A., and H. K. Symonds. 2002. Displacement of *Orcinus orca* (L.) by high amplitude sound in British Columbia, Canada. ICES Journal of Marine Science **59**:71-80.

Mueter, F. J., C. Broms, K. F. Drinkwater, K. D. Friedland, J. A. Hare, G. L. Hunt Jr, W. Melle, and M. Taylor. 2009. Ecosystem responses to recent oceanographic variability in high-latitude Northern Hemisphere ecosystems. **81**:18.

Mulsow, J., and C. Reichmuth. 2010. Psychophysical and electrophysiological aerial audiograms of a Steller sea lion (Eumetopias jubatus). The Journal of the Acoustical Society of America **127**:2692-2701.

Murray, N. K., and F. H. Fay. 1979. The white whales or belukhas, *Delphinapterus leucas*, of Cook Inlet, Alaska. Report prepared for the Standing Subcommittee of Small Cetaceans, International Whaling Commission Scientific Committee, Fairbanks, AK.

Muto, M. M., V. T. Helker, B. J. Delean, N. C. Young, J. C. Freed, R. P. Angliss, N. A. Friday, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, J. L. Crance, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, K. T. Goetz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2021. Alaska marine mammal stock assessments, 2020. Page 398 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Muto, M. M., V. T. Helker, B. J. Delean, N. C. Young, J. C. Freed, R. P. Angliss, N. A. Friday, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, J. L. Crance,

S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, K. T. Goetz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2022. Alaska marine mammal stock assessments, 2021. Page 398 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Neff, J. M. 1990. Composition and Fate of Petroleum and Spill-Treating Agents in the Marine Environment. Pages 1-33 *in* J. R. Geraci and D. J. St. Aubin, editors. Sea Mammals and Oil: Confronting the Risks. Academic Press, New York, NY.

Neilson, J., C. Gabriele, J. Straley, S. Hills, and J. Robbins. 2005. Humpback whale entanglement rates in southeast Alaska. Pages 203-204 Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Neilson, J. L., and C. Gabriele. 2020. Glacier Bay and Icy Strait humpback whale population monitoring: 2019 update. National Park Service Resource Brief, Gustavus, AK.

Neilson, J. L., C. M. Gabriele, A. S. Jensen, K. Jackson, and J. M. Straley. 2012. Summary of reported whale-vessel collisions in Alaskan waters. Journal of Marine Biology **2012**:Article ID 106282.

Nelson, M. A., L. T. Quakenbush, B. A. Mahoney, B. D. Taras, and M. J. Wooller. 2018. Fifty years of Cook Inlet beluga whale feeding ecology from isotopes in bone and teeth. Endangered Species Research **36**:77-87.

NMFS. 1991. Final recovery plan for the humpback whale (*Megaptera novaeangliae*). National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS. 2007. Proposed rule for listing of Cook Inlet beluga whales. Pages 19854-19862 *in* N. Department of Commerce, editor. Federal Register.

NMFS. 2008a. Conservation Plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). Page 122 p. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service Alaska Region, Protected Resources Division, Juneau, AK.

NMFS. 2008b. Recovery plan for the Steller sea lion (*Eumetopias jubatus*). Eastern and Western Distinct Population Segments (*Eumetopias jubatus*). Revision. Page 325 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, MD.

NMFS. 2010a. Endangered Species Act Section 7 Consulatation Biological Opinion for the authorization of groundfish fisheries under the Fishery Management Plan for Groundfish fo the Bering Sea and Aleutian Islands Management Area and the Fishery Management Plan for groundfish of the Gulf of Alaska.*in* A. R. National Marine Fisheries Service, editor., Juneau, AK.

NMFS. 2010b. Endangered Species Act, Section 7 consultation on the U.S. Environmental Protection Agency's proposed approval of the State of Alaska's mixing zone regulation section of the State of Alaska Water Quality Standards.75.

NMFS. 2015. Port of Anchorage Terminal No. 3 Repair. POA-2014-416, PCTS# AKR-2015-9432. National Marine Fisheries Service, Alaska Region, Protected Resources Division.

NMFS. 2016a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion for the Port of Anchorage Test Pile Project and Associated Proposed Issuance of Incidental Harassment Authorization and NWP Verification. NMFS Consultation Number AKR-2016-9513. *.in* A. R. National Marine Fisheries Service, editor., Anchorage, AK.

NMFS. 2016b. Recovery plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

NMFS. 2017a. Biological Opinion for Furie's Offshore Oil and Gas Exploration Drilling in the Kitchen lights Unit of Cook Inlet, Alaska. NOAA National Marine Fisheries Service.

NMFS. 2017b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion for Lease Sale 244, Cook Inlet, Alaska 2017-2022.*in* N. Department of Commerce, NMFS, editor., Anchorage, AK.

NMFS. 2018a. Assessment of the Pacific cod stock in the Gulf of Alaska.*in* N. Department of Commerce, editor. Alaska Fisheries Science Center, Seattle, WA.

NMFS. 2018b. Endangered Species Act Section 7 Letter of Concurrence for Furie's offshore oil and gas exploration drilling in the Kitchen Lights Unit of Cook Inlet, Alaska, 2018-2021. Page 46 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

NMFS. 2018c. Endangered Species Act Section 7 Letter of Concurrence for Port of Alaska Petroleum and Cement Terminal transitional dredging and offshore disposal of dredged material. Page 23 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

NMFS. 2018d. Endangered Species Act Section 7(a)(2) Biological Opinion on the Issuance of a U.S. Army Corps of Engineers Permit and Incidental Harassment Authorization for Harvest Alaska LLC Cook Inlet Pipeline Cross-Inlet Extension Project.*in* N. Department of Commerce, editor., Anchorage, AK.

NMFS. 2018e. Letter of Concurrence for ESA section 7 Consultation on the Port of Alaska Fender Pile Replacement and Repair, Knik Arm, Anchorage, AK. NMFS PCTS# AKR-

2018-9778 National Marine Fisheries Service, Alaska Region, Protected Resources Division, Anchorage, AK.

NMFS. 2018f. Revision to technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 2.0): underwater acoustic thresholds for onset of permanent and temporary threshold shifts. Page 178 p. U.S. Dept. of Commerce, National Oceanic and Atmospherica Administraiton, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD.

NMFS. 2019a. ESA Section 7 Biological and Conference Opinion on the proposed implementation of a program for the issuance of permits for research and enhancement activities on cetaceans in the Arctic, Atlantic, Indian, Pacific, and Southern oceans. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Permits and Conservation Division, Silver Spring, MD.

NMFS. 2019b. Takes of marine mammals incidental to specified activities; Taking marine mammals incidental to oil and gas activities in Cook Inlet, Alaska. Pages 37442-37506. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Permits and Conservation Division, Silver Spring, MD.

NMFS. 2020. 5-year review: summary and evaluation of western Distinct Population Segment Steller sea lion *Eumetopias jubatus*. Page 61 p. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

Norman, S. A. 2011. Nonlethal anthropogenic and environmental stressors in Cook Inlet beluga whales (*Delphinapterus leucas*). Report prepared for National Marine Fisheries Service under contract number HA133F-10-SE-3639, Anchorage, AK.

Norman, S. A., R. C. Hobbs, L. A. Beckett, S. J. Trumble, and W. A. Smith. 2020. Relationship between per capita births of Cook Inlet belugas and summer salmon runs: age-structured population modeling. Ecosphere **11**:e02955.

Norman, S. A., R. C. Hobbs, C. E. Goertz, K. A. Burek-Huntington, K. E. Shelden, W. A. Smith, and L. A. Beckett. 2015. Potential natural and anthropogenic impediments to the conservation and recovery of Cook Inlet beluga whales, Delphinapterus leucas. Mar. Fish. Rev **77**:89-105.

Norse, E. A., and L. B. Crowder. 2005. Marine Conservation Biology: the science of maintaining the sea's biodiversity. Island Press, Washington, D.C.

Nowacek, D. P., C. W. Clark, D. Mann, P. J. O. Miller, H. C. Rosenbaum, J. S. Golden, M. Jasny, J. Kraska, and B. L. Southall. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. Frontiers in Ecology and the Environment **13**:378-

386.

Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review **37**:81-115.

NRC. 2003. Ocean Noise and Marine Mammals. National Research Council, Ocean Study Board, National Academy Press, Washington, D.C.

Nuka Research and Planning and Pearson Consulting LLC. 2015. Cook Inlet Risk Assessment Final Report.

Nuka Research and Planning Group, L. 2016. Bering Sea vessel traffic risk analysis.

O'Shea, T. J., and J. R. L. Brownell. 1994. Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservaiton implications. The Science of the Total Environment **154**:179-200.

Orr, J. C., V. J. Fabry, O. Aumont, L. Bopp, S. C. Doney, R. A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida, F. Joos, R. M. Key, K. Lindsay, E. Maier-Reimer, R. Matear, P. Monfray, A. Mouchet, R. G. Najjar, G.-K. Plattner, K. B. Rodgers, C. L. Sabine, J. L. Sarmiento, R. Schlitzer, R. D. Slater, I. J. Totterdell, M.-F. Weirig, Y. Yamanaka, and A. Yool. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature **437**:681-686.

Ovitz, K. 2019. Exploring Cook Inlet beluga whale (*Delphinapterus leucas*) habitat use in Alaska's Kenai River. Prepared for National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Protected Resources Division, Anchorage, AK.

Patenaude, N. J., W. J. Richardson, M. A. Smultea, W. R. Koski, G. W. Miller, B. Würsig, and C. R. Greene Jr. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. Marine Mammal Science **18**:309-335.

Payne, K., and R. Payne. 1985. Large scale changes over 19 years in songs of humpback whales in Bermuda. Zeitschrift für Tierpsychologie **68**:89-114.

Payne, R. S. 1970. Songs of the humpback whale. Capitol Records, Hollywood, CA.

Pearson, W. H., J. R. Skalski, and C. I. Malme. 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish (Sebastes spp.). Canadian Journal of Fisheries and Aquatic Sciences **49**:1343-1356.

Perrin, W. F. 1999. Selected examples of small cetaceans at risk. Conservation and management of marine mammals:296-310.

Perry, S. L., D. P. DeMaster, and G. K. Silber. 1999. The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973: a special issue of the Marine Fisheries Review. Marine Fisheries Review **61**:1-74.

Petersen, S., A. Krätschell, N. Augustin, J. Jamieson, J. R. Hein, and M. D. Hannington. 2016. News from the seabed – Geological characteristics and resource potential of deep-sea mineral resources. Marine Policy **70**:175-187.

Peterson, W., N. Bond, and M. Robert. 2016. The blob (part three): Going, going, gone? PICES Press **24**:46.

Pitcher, K. W., and D. G. Calkins. 1981. Reproductive biology of Steller sea lions in the Gulf of Alaska. Journal of Mammalogy **62**:599-605.

Pitcher, K. W., and F. H. Fay. 1982. Feeding by Steller sea lions on harbor seals. The Murrelet:70-71.

POA. 2003. Environmental baseline survey for the Port of Anchorage road and rail extension right of way. U.S. Army Defense Fuels Property.

POA. 2019. June 2019 Marine Mammal Observation Report. Submitted to NMFS July 15, 2019. Anchorage, AK.

Poirier, M. C., S. Lair, R. Michaud, E. E. Hernández-Ramon, K. V. Divi, J. E. Dwyer, C. D. Ester, N. N. Si, M. Ali, and L. L. Loseto. 2019. Intestinal polycyclic aromatic hydrocarbon-DNA adducts in a population of beluga whales with high levels of gastrointestinal cancers. Environmental and molecular mutagenesis **60**:29-41.

Popper, A., T. Carlson, B. Casper, and M. Halvorsen. 2014. Does man-made sound harm fishes. Journal of Ocean Technology **9**:11-20.

Popper, A. N., and A. D. Hawkins. 2019. An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. Journal of Fish Biology **94**:692-713.

Qi, D., L. Chen, B. Chen, Z. Gao, W. Zhong, Richard A. Feely, Leif G. Anderson, H. Sun, J. Chen, M. Chen, L. Zhan, Y. Zhang, and W.-J. Cai. 2017. Increase in acidifying water in the western Arctic Ocean. Nature Climate Change **7**:195-199.

Quakenbush, L., R. S. Suydam, A. L. Bryan, L. F. Lowry, K. J. Frost, and B. A. Mahoney. 2015. Diet of beluga whales (Delphinapterus leucas) in Alaska from stomach contents, March–November. Mar Fish Rev **77**:70-84.

Raum-Suryan, K. L., L. A. Jemison, and K. W. Pitcher. 2009. Entanglement of Steller sea lions (*Eumetopias jubatus*) in marine debris: Identifying causes and finding solutions. Marine Pollution Bulletin **58**:1487-1495.

Rea, L. D., J. M. Castellini, L. Correa, B. S. Fadely, and T. M. O'Hara. 2013. Maternal Steller sea lion diets elevate fetal mercury concentrations in an area of population decline. Science of The Total Environment **454-455**:277-282.

Reijnders, P. J. H. 1986. Reproductive failure in common seals feeding on fish from polluted coastal waters. Nature **324**:456-457.

Reisdorph, S. C., and J. T. Mathis. 2014. The dynamic controls on carbonate mineral saturation states and ocean acidification in a glacially dominated estuary. Estuarine, Coastal and Shelf Science **144**:8-18.

Reynolds, J., and D. Wetzel. 2010. Polycyclic aromatic hydrocarbon (PAH) contamination in Cook Inlet belugas. Pages 122-166 *in* Cook Inlet Beluga Whale Science Conference Anchorage Alaska.

Rice, D. W. 1998. Marine mammals of the world: systematics and distribution. Society for Marine Mammology, Lawrence, KS.

Richardson, W. J., C. R. Greene Jr, C. I. Malme, and D. H. Thomson. 1995. Marine mammals and noise. Academic Press, Inc., San Diego, CA.

Richardson, W. J., and C. I. Malme. 1993. Man-made noise and behavioral responses. Pages 631-700 *in* J. J. Burns, J. J. Montague, and C. J. Cowles, editors. The Bowhead Whale. Society for Marine Mammology, Allen Press, Inc., Lawrence, KS.

Richardson, W. J., B. Wursig, and C. R. Greene. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. Journal of the Acoustical Society of America **79**:1117-1128.

Richter-Menge, J., M. L. Druckenmiller, and M. Jeffries, editors,. 2019. Arctic Report Card 2019. http://www.arctic.noaa.gov/Report-Card.

Richter-Menge, J., J. E. Overland, J. T. Mathis, E. Osborne, and Eds.;. 2017. Arctic Report Card 2017, http://www.arctic.noaa.gov/Report-Card.

Ridgway, S. H., D. A. Carder, T. Kamolnick, R. R. Smith, C. E. Schlundt, and W. R. Elsberry. 2001. Hearing and whistling in the deep sea: Depth influences whistle spectra but does not attenuate hearing by white whales (*Delphinapterus leucas*) (Odontoceti, Cetacea). Journal of Experimental Biology **204**:3829-3841.

Ridgway, S. H., D. A. Carder, R. R. Smith, T. Kamolnick, C. E. Schlunt, and W. R. Elsberry. 1997. Behavioural responses and temporary shift in masked hearing threshold of bottlenose dolphins, *Tursiops truncatus*, to 1-second tones of 141 to 201 dB re 1 mPa. Naval Command, Control and Surveillance Center, RDT&E Division, San Diego, California.

Rodkin, I. a. 2009. Acoustic Monitoring and In-situ Exposures of Juvenile Coho Salmon to Pile Driving Noise at the Port of Anchorage Marine Terminal Redevelopment Project Knik Arm, Anchorage, Alaska. Prepared for USDOT and POA.

Rolland, R. M., S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K.

Wasser, and S. D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B: Biological Sciences **279**:2363-2368.

Romano, T. A., D. L. Felten, S. Y. Stevens, J. A. Olschowka, V. Quaranta, and S. H. Ridgway. 2002. Immune response, stress, and environment: Implications for cetaceans. Pages 253-279 *in* C. J. Pfeiffer, editor. Molecular and Cell Biology of Marine Mammals. Krieger Publishing Co., Malabar, FL.

Rugh, D. J., K. E. Shelden, and B. A. Mahoney. 2000. Distribution of belugas, *Delphinapterus leucas*, in Cook Inlet, Alaska, during June/July 1993–2000. Marine Fisheries Review **62**:6-21.

Rugh, D. J., K. E. Shelden, C. L. Sims, B. A. Mahoney, B. K. Smith, L. K. Litzky, and R. C. Hobbs. 2005. Aerial surveys of beluga in Cook Inlet, Alaska, June 2001, 2002, 2003, and 2004. Page 71 p. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Rugh, D. J., K. E. W. Shelden, and R. C. Hobbs. 2010. Range contraction in a beluga whale population. Endangered Species Research **12**:69-75.

Ruiz, G. M., T. Huber, K. Larson, L. McCann, B. Steves, P. Fofonoff, and A. H. Hines. 2006. Biological invasions in Alaska's coastal marine ecosystems: establishing a baseline. Smithsonian Environmental Research Center.

Sandegren, F. E. 1970. Breeding and maternal behavior of the Steller sea lion (*Eumetopias jubata*) in Alaska. University of Alaska, Fairbanks, AK.

Saupe, S. M., T. M. Willette, D. L. Wetzel, and J. E. Reynolds. 2014. Assessment of the prey availability and oi-related contaminants in winter habitat of Cook Inlet beluga whales. Technical Report Number 1761, Mote Marine Laboratory.

Scheifele, P. M., S. Andrew, R. A. Cooper, M. Darre, F. E. Musiek, and L. Max. 2005. Indication of a Lombard vocal response in the St. Lawrence River beluga. The Journal of the Acoustical Society of America **117**:1486-1492.

Schenk, C. J., P. H. Nelson, T. R. Klett, P. A. Le, and C. P. Anderson. 2015. Assessment of unconvential (tight) gas resources in Upper Cook Inlet Basin, South-central Alaska. US Geological Survey.

Serreze, M. C., and R. G. Barry. 2011. Processes and impacts of Arctic amplification: a research synthesis. Global and Planetary Change **77**:85-96.

Sharpe, F. A., and L. M. Dill. 1997. The behavior of Pacific herring schools in response to artificial humpback whale bubbles. Canadian Journal of Zoology-Revue Canadienne De Zoologie **75**:725-730.

Shelden, K. E., R. C. Hobbs, K. T. Goetz, L. Hoberecht, K. L. Laidre, T. McGuire, B. A.

Mahoney, S. Norman, G. O'Corry-Crowe, and D. Vos. 2018. Beluga whale, Delphinapterus leucas, satellite-tagging and health assessments in Cook Inlet, Alaska, 1999 to 2002.

Shelden, K. E., C. L. Sims, L. Vate Brattström, K. T. Goetz, and R. C. Hobbs. 2015a. Aerial surveys of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2014.

Shelden, K. E. W., K. T. Goetz, D. J. Rugh, D. G. Calkins, B. A. Mahoney, and R. C. Hobbs. 2015b. Spatio-temporal changes in beluga whale, *Delphinapterus leucas*, distribution: results from aerial surveys (1977-2014), opportunistic sightings (1975-2014), and satellite tagging (1999-2003) in Cook Inlet, Alaska. Marine Fisheries Review **77**:1-32.

Shelden, K. E. W., R. C. Hobbs, C. L. Sims, L. Vate Brattstrom, J. A. Mocklin, C. Boyd, and B. A. Mahoney. 2017. Aerial surveys, abundance, and distribution of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2016., NOAA National Marine Fisheries Service, Seattle, WA.

Shelden, K. E. W., T. R. Robeck, C. E. C. Goertz, T. L. McGuire, K. A. Burek-Huntington, D. J. Vos, and B. A. Mahoney. 2020. Breeding and calving seasonality in the endangered Cook Inlet beluga whale population: Application of captive fetal growth curves to fetuses and newborns in the wild. Marine Mammal Science **36**:700-708.

Shelden, K. E. W., D. J. Rugh, K. T. Goetz, C. L. Sims, L. Vate Brattstrom, J. A. Mocklin, B. A. Mahoney, B. K. Smith, and R. C. Hobbs. 2013. Aerial Surveys of beluga whales, *Delphinapterus leucas*, in Cook Inlet, Alaska, June 2005 to 2012. NOAA Technical Memo. NMFS-AFSC-263, 131 pp.

Shelden, K. E. W., D. J. Rugh, B. A. Mahoney, and M. E. Dahlheim. 2003. Killer whale predation on belugas in Cook Inlet, Alaska: implications for a depleted population. Marine Mammal Science **19**:529-544.

Shelden, K. E. W., and P. R. Wade. 2019. Aerial surveys, distribution, abundance, and trend of belugas (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2018. Page 93 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Shields, P., and A. Dupuis. 2017. Upper Cook Inlet commercial fisheries annual management report, 2016. Fishery Management Report No. 17-05, Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries, Anchorage, AK.

Silber, G. K. 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae*). Canadian Journal of Zoology **64**:2075-2080.

Simon, M., M. Johnson, and P. T. Madsen. 2012. Keeping momentum with a mouthful of water: behavior and kinematics of humpback whale lunge feeding. Journal of Experimental

Biology **215**:3786-3798.

Sitkiewicz, S., W. Hetrick, K. Leonard, and S. Wisdom. 2018. 2018 Harvest Alaska Cook Inlet Pipeline Project Monitoring Program Marine Mammal Monitoring and Mitigation Report. Prepared by Fairweather Science for Harvest Alaska, LLC, Anchorage, AK.

Sjare, B. L., and T. G. Smith. 1986. The relationship between behavioral activity and underwater vocalizations of the white whale, Delphinapterus leucas. Canadian Journal of Zoology **64**:2824-2831.

Skalski, J. R., W. H. Pearson, and C. I. Malme. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (Sebastes spp.). Canadian Journal of Fisheries and Aquatic Sciences **49**:1357-1365.

Slabbekoorn, H., N. Bouton, I. van Opzeeland, A. Coers, C. ten Cate, and A. N. Popper. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in ecology & evolution **25**:419-427.

Smultea Environmental Sciences, L. 2016. Susitna Delta Exclusion Zone report for marine mammal monitoring and mitigation during ExxonMobile Alaska LNG LLC 2016 geophysical and geotechnical survey in Cook Inlet.:14.

Sonune, A., and R. Ghate. 2004. Developments in wastewater treatment methods. Desalination **167**:55-63.

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. Greene Jr., D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals **33**:411-521.

Spalding, D. J. 1964. Comparative feeding habits of the fur seal, sea lion and harbour seal on the British Columbia coast. Page 52 p. Bulletin of the Fisheries Research Board of Canada No. 146, Ottawa, Ontario.

St. Aubin, D. J. 1988. Physiologic and toxicologic effects on pinnipeds. Synthesis of Effects of Oil on Marine Mammals.

St. Aubin, D. J. 1990. Physiologic and toxic effects on pinnipeds. Pages 103-127 *in* J. R. a. S. A. Geraci, D. J., editor. Sea mammals and oil, confronting the risks. Academic Press, San Diego, CA.

Steiger, G. H., J. Calambokidis, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urban-R., J. K. Jacobsen, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, S. Uchida, J. K. B. Ford, P. Ladron de Guevara-P., M. Yamaguchi, and J. Barlow. 2008. Geographic variation in killer whale attacks on humpback whales in the North Pacific: Implications for predation pressure. Endangered Species Research **4**:247-256.

Stewart, B., W. Evans, and F. Awbrey. 1982. Effects of man-made waterborne noise on behavior of belukha whales (Delphinapterus leucas) in Bristol Bay, Alaska. Unpublished report for National Oceanic and Atmospheric Administration, Juneau, Alaska, by Hubbs/Sea World Research Institute, San Deigo, California. HSWRI Technical Report:82-145.

Stoeger, A. S., D. Mietchen, S. Oh, S. de Silva, C. T. Herbst, S. Kwon, and W. T. Fitch. 2012. An Asian elephant imitates human speech. Current Biology **22**:2144-2148.

Straley, J. M., J. R. Moran, K. M. Boswell, J. J. Vollenweider, R. A. Heintz, T. J. Quinn Ii, B. H. Witteveen, and S. D. Rice. 2018. Seasonal presence and potential influence of humpback whales on wintering Pacific herring populations in the Gulf of Alaska. Deep Sea Research Part II: Topical Studies in Oceanography **147**:173-186.

Stroeve, J., M. M. Holland, W. Meier, T. Scambos, and M. Serreze. 2007. Arctic sea ice decline: Faster than forecast. Geophysical Research Letters **34**.

Stroeve, J., and D. Notz. 2018. Changing state of Arctic sea ice across all seasons. Environmental Research Letters **13**:103001.

Suryan, R. M., M. L. Arimitsu, H. A. Coletti, R. R. Hopcroft, M. R. Lindeberg, S. J. Barbeaux, S. D. Batten, W. J. Burt, M. A. Bishop, J. L. Bodkin, R. Brenner, R. W. Campbell, D. A. Cushing, S. L. Danielson, M. W. Dorn, B. Drummond, D. Esler, T. Gelatt, D. H. Hanselman, S. A. Hatch, S. Haught, K. Holderied, K. Iken, D. B. Irons, A. B. Kettle, D. G. Kimmel, B. Konar, K. J. Kuletz, B. J. Laurel, J. M. Maniscalco, C. Matkin, C. A. E. McKinstry, D. H. Monson, J. R. Moran, D. Olsen, W. A. Palsson, W. S. Pegau, J. F. Piatt, L. A. Rogers, N. A. Rojek, A. Schaefer, I. B. Spies, J. M. Straley, S. L. Strom, K. L. Sweeney, M. Szymkowiak, B. P. Weitzman, E. M. Yasumiishi, and S. G. Zador. 2021. Ecosystem response persists after a prolonged marine heatwave. Scientific Reports **11**:6235.

Sweeney, K., B. Birkemeier, K. Luxa, and T. Gelatt. 2023. Results of the Steller sea lion surveys in Alaska, June-July 2022. Page 32 p. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Sweeney, K., L. Fritz, R. Towell, and T. Gelatt. 2017. Results of Steller sea lion surveys in Alaska, June-July 2017. Memorandum to the Record, December 5, 2017.*in* National Marine Fisheries Service Alaska Fisheries Science Center, editor.

Sweeney, K., R. Towell, and T. Gelatt. 2018. Results of Steller Sea Lion Surveys in Alaska, June-July 2018: Memorandum to The Record. U.S. Dept. of Commerce, NOAA, NMFS, Alaska Fisheries Science Center, Marine Mammal Laboratory, Seattle, WA. December 4, 2018.

Thoman, R., and J. Walsh. 2019. Alaska's Changing Environment: documenting Alaska's physical and biological changes through observations., International Arctic Research

Center, University of Alaska Fairbanks.

Thompson, P. O., W. C. Cummings, and S. J. Ha. 1986. Sounds, source levels, and associated behavior of humpback whales, Southeast Alaska. Journal of the Acoustical Society of America **80**:735-740.

Thompson, T. J., H. E. Winn, and P. J. Perkins. 1979. Mysticete sounds. Pages 403-431 *in* H. E. Winn and B. L. Olla, editors. Behavior of Marine Animals: Current Perspectives in Research Vol. 3: Cetaceans. Plenum Press, New York, NY.

Thorson, P., and J. Reyff. 2006. San Francisco-Oakland Bay bridge east span seismic safety project marine mammals and acoustic monitoring for the marine foundations at piers E2 and T1, January-September 2006. Prepared by SRS Technologies and Illingworth & Rodkin, Inc. for the California Department of Transportation: 51 p.

Tomilin, A. 1967. Mammals of the USSR and adjacent countries. Cetacea **9**:666-696.

Trites, A. W., B. P. Porter, V. B. Deecke, A. P. Coombs, M. L. Marcotte, and D. A. Rosen. 2006. Insights into the timing of weaning and the attendance patterns of lactating Steller sea lions (*Eumetopias jubatus*) in Alaska during winter, spring, and summer. Aquatic Mammals **32**:85.

Tyack, P., and H. Whitehead. 1983. Male competition in large groups of wintering humpback whales. Behaviour **83**:132-154.

Tyack, P. L. 1981. Interactions between singing Hawaiian humpback whales and conspecifics nearby. Behavioral Ecology and Sociobiology **8**:105-116.

Tyack, P. L. 1999. Communication and cognition. Biology of marine mammals:287-323.

U. S. Army. 2010. Biological Assessment of the Cook Inlet beluga whale (*Delphinapterus leucas*) for the resumption of year-round firing in Eagle River flats impact area, Fort Richardson, Alaska.

USACE. 2008. Environmental assessment and finding of no significant impact: Anchorage Harbor dredging and disposal.*in* A. Division, editor. U.S. Army Corps of Engineers, Ancorage, Alaska.

USACE. 2009. Biological Assessment of the beluga whale *Delphinapterus leucas* in Cook Inlet for the Port of Anchorage expansion project and associated dredging at the Port of Anchorage, Alaska.

USACE. 2019. Annual marine mammal report for the Alaska District's Port of Alaska maintenance dredging for the 2018 dredging season. Memorandum for the National Marine Fisheries Service, Protected Resources Division.

Vincent-Lang, D., and I. Queral. 1984. Chapter 5: Eulachon spawning habitat in the lower

Susitna River. Susitna Hydro Aquatic Studies Report.

von Biela, V. R., L. Bowen, S. D. McCormick, M. P. Carey, D. S. Donnelly, S. Waters, A. M. Regish, S. M. Laske, R. J. Brown, and S. Larson. 2020. Evidence of prevalent heat stress in Yukon River Chinook salmon. Canadian Journal of Fisheries and Aquatic Sciences **77**:1878-1892.

Vos, D. J., and K. E. W. Shelden. 2005. Unusual mortality in the depleted Cook Inlet beluga (*Delphinapterus leucas*) population. Northwestern Naturalist **86**:59-65.

Wade, P. R. 2021. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas. National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Wania, F., and D. Mackay. 1993. Global fractionation and cold condensation of low volatility organochlorine compounds in polar regions. AMBIO **22**:10-18.

Ward, E. J., E. E. Holmes, and K. C. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. Journal of Applied Ecology **46**:632-640.

Wartzok, D., A. N. Popper, J. Gordon, and J. Merrill. 2003. Factors Affecting the Responses of Marine Mammals to Acoustic Disturbance. Marine Technology Society Journal **37**:6-15.

Wasser, S. K., J. I. Lundin, K. Ayres, E. Seely, D. Giles, K. Balcomb, J. Hempelmann, K. Parsons, and R. Booth. 2017. Population growth is limited by nutritional impacts on pregnancy success in endangered Southern Resident killer whales (Orcinus orca). PLoS One **12**:e0179824.

Weilgart, L. S. 2007. A brief review of known effects of noise on marine mammals. International Journal of Comparative Psychology **20**:159-168.

Westley, P. A. 2020. Documentation of en route mortality of summer chum salmon in the Koyukuk River, Alaska and its potential linkage to the heatwave of 2019. Ecology and Evolution **10**:10296-10304.

Whitehead, H. 2016. Consensus movements by groups of sperm whales. Marine Mammal Science **32**:1402-1415.

Wiese, K. 1996. Sensory capacities of euphausiids in the context of schooling. Marine and Freshwater Behaviour and Physiology **28**:183-194.

Wieting, D. S. 2016. Interim Guidance on the Endangered Species Act Term "Harass". U.S. Dept. of Commerce, NOAA, NMFS, Office of Protected Resources, Silver Spring, MD.

Wiggin, M. 2017. Alaska's Oil and Gas Industry: Overview and Activity Update, Commonwealth North. Alaska Department of Natural Resources.

Wild, L. A., H. E. Riley, H. C. Pearson, C. M. Gabriele, J. L. Neilson, A. Szabo, J. Moran, J. M. Straley, and S. DeLand. 2023. Biologically Important Areas II for cetaceans within U.S. and adjacent waters–Gulf of Alaska region. Frontiers in Marine Science **10**:763.

Winn, H. E., P. J. Perkins, and T. C. Poulter. 1970. Sounds of the humpback whale. Pages 39-52 7th Annual Conference on Biological Sonar and Diving Mammals, Stanford Research Institute, Menlo Park.

Withrow, D. 1982. Using aerial surveys, ground truth methodology, and haul out behavior to census Steller sea lions, *Eumetopias jubatus*. University of Washington, Seattle, WA.

Wright, A. J., N. A. Soto, A. L. Baldwin, M. Bateson, C. M. Beale, C. Clark, T. Deak, E. F. Edwards, A. Fernández, and A. Godinho. 2007. Anthropogenic noise as a stressor in animals: a multidisciplinary perspective. International Journal of Comparative Psychology **20**.

Wright, S. 2016. 2016 Copper River Delta Carcass Surveys, Annual Report. National Marine Fisheries Service, Alaska Region Protected Resources Division, Juneau, AK.

Wright, S. 2021. 2019 Copper River Delta Carcass Surveys, Annual Report. National Marine Fisheries Service, Alaska Region Protected Resources Division, Juneau, AK.

Yamamoto, A., M. Kawamiya, A. Ishida, Y. Yamanaka, and S. Watanabe. 2012. Impact of rapid sea-ice reduction in the Arctic Ocean on the rate of ocean acidification. Biogeosciences **9**:2365-2375.

York, A. E. 1994. The population dynamics of northern sea lions, 1975-1985. Marine Mammal Science **10**:38-51.

Young, N. C., M. M. Muto, V. T. Helker, B. J. Delean, J. C. Freed, R. P. Angliss, N. A. Friday, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, J. L. Crance, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, K. T. Goetz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2023. Alaska marine mammal stock assessments, 2022. Page 316 p. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA.

Zimmermann, M., and M. Prescott. 2014. Smooth Sheet Bathymetry of Cook Inlet, Alaska.